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IN THEIR WIDEST SENSE.

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AMERICAN NATURALIST

VOL. XXVI. July, 1892. 307

THE DIFFICULTIES IN THE HEREDITY THEORY.

By HENRY FAIRFIELD OSBORN.

THE CARTWRIGHT LECTURES FOR 1892, II.

(*Continued from Page 481, Vol. XXVI.*)

"Nur muss ich nochmals betonen, dass nach meiner Auffassung der Anfang einer neuen Reihe erblicher Abweichungen, also auch der Eintritt einer neuen Art ohne eine vorausgegangene erworbene Abweichung undenkbar ist."—VIRCHOW.

State of Opinion.—The above quotation from one of the most eminent authorities of our times represents the unshaken conviction of a very large class upon one side of the question of transmission of acquired characters, which is met by equally firm conviction upon the other side.

Herbert Spencer, whose entire system of biology, psychology, and ethics is based upon such transmission, says: "I will only add that, considering the width and depth of the effects which acceptance of one or other of these hypotheses must have on our views of Life, Mind, Morals, and Politics, the question Which of them is true? demands, beyond all other questions whatever, the attention of scientific men."[1] This shows that Spencer considers the matter still *sub judice*, and lest you may think I am bringing before you an issue in which learning and experience are ranged against ignorance and prejudice, I have taken some pains, by correspondence

[1]Nineteenth Century, 1889.

with a number of friends abroad, to learn the present state of opinion. The two leading English and French authorities upon this subject express themselves doubtfully.

Galton's mind is still wavering, as in his work of 1889:[1] "I am unprepared to say more than a few words on the obscure, unsettled and much discussed subject of the possibility of transmitting acquired faculties. . . . There is very little direct evidence of its influence in the course of a single generation, if the phrase of Acquired Faculties is used in perfect strictness and all inheritance is excluded that could be referred to some form of Natural Selection, or of Infection before birth, or of peculiarities of Nurture and Rearing."

Ribot, although in the center of the French Lamarckians, says: "Notwithstanding these facts the transmission of acquired modifications appears to be very limited, even when occurring in both of the parents."

Excepting from Kölliker; His, the Leipzig anatomist; Pflüger, the physiologist; Ziegler, in pathology; and De Vries, in botany, Weismann has not found much sympathy from his own countrymen in his opinion "that acquired characters cannot be transmitted; . . . that there are no proofs of such transmission, that its occurrence is theoretically improbable, and that we must attempt to explain the transformation of species without its aid."[2] Besides Virchow[3] and Eimer,[4] Haeckel has expressed himself strongly against Weismann. My colleague, Professor Wilson, writes me (Munich, December 31, 1891) that, while Weismann's modified theories as to the phenomena in the productive cells are pretty generally accepted, Hertwig, Hofer, Paully, Boveri, and others are pronounced advocates of the acquired-character-transmission theory.

In Paris, Brown-Sequard, who was among the first to test this problem experimentally by observing the inheritance of the effects of nerve-lesions; his assistant Dupuy, Giard, Duval,

[1]Natural Inheritance, 1889, p. 14.

[2]Biologisches Centralblatt, 1888, pp. 65 and 97.

[3]Ueber den Transformismus, Archiv. f. Anthropologie, 1889, p. 1.

[4]Organic Evolution, upon the Law of Inheritance of Acquired Characters. Tübingen, 1888. Trans.

Blanchard, and others are on the affirmative, or Lamarckian side.

Physiologists generally have fought shy of the question, although I think in the end they will be forced to take it up with the morphologists, and give us the physio-morphological theory of heredity of the future. Professor Michael Foster of Cambridge, and Professor Burdon-Sanderson, of Oxford, both write me that the question has hardly come into the physiological stage of inquiry at all. Yet in England Weismann has found his strongest supporters among some of the naturalists: Wallace, Lankester, Thiselton Dyer, Meldola, Poulton, Howes, and others; while, excepting Windle, the anatomists, including Mivart and Lawson Tait, with Sir William Turner as the most prominent, are all Lamarckians. Huxley, Romanes, and Flower are said to be doubtful. In this country the opinion of naturalists is directly the outgrowth of the class of studies in which each happens to be engaged. So far as I know every vertebrate and invertebrate palæontologist is a Lamarckian,[1] for in this field all evolution seems to follow the lines of inherited use and disuse; most of those engaged upon invertebrate zoology incline to follow Weismann. I have conversed upon this subject with many physicians, and find that without exception the transmission of acquired characters is an accepted fact among the profession.

Exact Statement of the Problem.—It is important at the outset to state most clearly what is and what is not involved in this discussion. Weismann[2] does not claim that the reproductive or germ-cells are uninfluenced by habit; on the other hand, he admits that most important modifications in these cells may and do result from changes of food, climate, from healthy or unhealthy conditions of the body; also from infectious disease, where it is quite as possible that the microbes may enter the reproductive cells as any other cells of the body; from alcoholism, where the normal molecular action of the protoplasm of the germ-cells may be disturbed,

[1]See the writings of Hyatt, Cope, Ryder, Dall, Scott, and others.

[2]See Essays upon Heredity and Kindred Biological Problems, 1889. Trans.

resulting in abnormal development, and there are some very interesting experiments which I shall cite on this point; from some nervous disorders which profoundly modify cell-function in all the tissues; in other words, *ovum sanum in corpore sano.* But to accept all this, and even to include all our rapidly increasing knowledge of the direct relation between such phenomena as production of deformities and determination of sex, and the influences of environment upon the ovum; or the influences of the mother upon the fœtus—this is all aside from the real question at issue.

It may be stated thus: Given *G*, the ova and spermatozoa, the germ-cells or material vehicles of hereditary characters; *S*, the body of somatic cells of all the other tissues conveying the hereditary characters of nerve, muscle, and bone; *V*, the variations in these body-cells "acquired" during lifetime; given these factors, the real question is: Do influences at work producing variations in certain body-cells of the parent so affect the germ-cells of the parent that they reappear in corresponding body-cells of the offspring? To take a concrete case, will the increased use of the cells of the extensor indicis muscle in the parent so stimulate that portion of the germ-cells which represents this muscle that the increment of growth will in any degree reappear in the offspring?

This is what is required of heredity upon the Lamarckian hypothesis, and I think you will see at once that while this hypothesis simplifies the problem of evolution it in a corresponding degree renders more difficult the problem of heredity —for we have not the first ray of knowledge of what such a process involves. There is no quality more essential to the scientific progress than common honesty; if we take a position let us face all its consequences; the more we reflect upon it, the more serious the Lamarckian position becomes.

In the present lecture let us first briefly review the progress of the science of heredity which has led up to the present discussion. Second, Let us examine the evidence for and against the Lamarckian theory, and inquire how far natural selection can explain all the facts of evolution. Third, Let us examine the evidence for such a continuous relation between

the body-cells and the germ-cells, as must exist if the Lamarckian theory is the true one.

History of the Heredity Theory.—In a valuable summary of the past theories of heredity[1] J. A. Thomson distinguishes three general problems, which are often confused. 1st. What characters distinguish the germ-cells from other cells of the body? 2d. How do the germ-cells derive these distinguishing characters? 3d. How shall we interpret "particulate" inheritance, or the reappearance of single peculiarities in the offspring?

The various theories may be grouped under two heads, "Pangenesis of Germ-cells" and "Continuity of Germ-cells," according to the dominating idea in each.

1. *Pangenesis.*—The idea prevading pangenesis was first expressed by Democritus that the "seed" of animals was derived by contributions of material particles from all parts of the bodies of both sexes, and that like parts produced like. Two thousand years later, Buffon revived this conception of heredity in his "molecules organiques." In 1864 Herbert Spencer suggested the existence of "physiological units," derived from the body-cells of the parent, forming the germ-cells and then developing into the body-cells of the offspring.

It is interesting to note the course of Darwin's thought upon this matter in his published works and in his "Life and Letters." He was at first strongly opposed to the views upon evolution advanced by Buffon, by Erasmus Darwin, his grandfather, expanded by Lamarck, and now known as Lamarckian. But gradually becoming convinced that his own theory of natural selection could not account for all the facts of evolution, he unconsciously became a strong advocate of Lamarck's theory, and contributed to it a feature which Lamarck had entirely omitted, namely, a theory of heredity expressly designed to explain the transmission of acquired characters. Darwin's[2] "provisional hypothesis of pangenesis" postulated a material connection between the body-cells and

[1]See Proc. Roy. Soc. Edin., 1888, p. 93.
[2]See Animals and Plants under Domestication, 1875, vol. ii., p. 349.

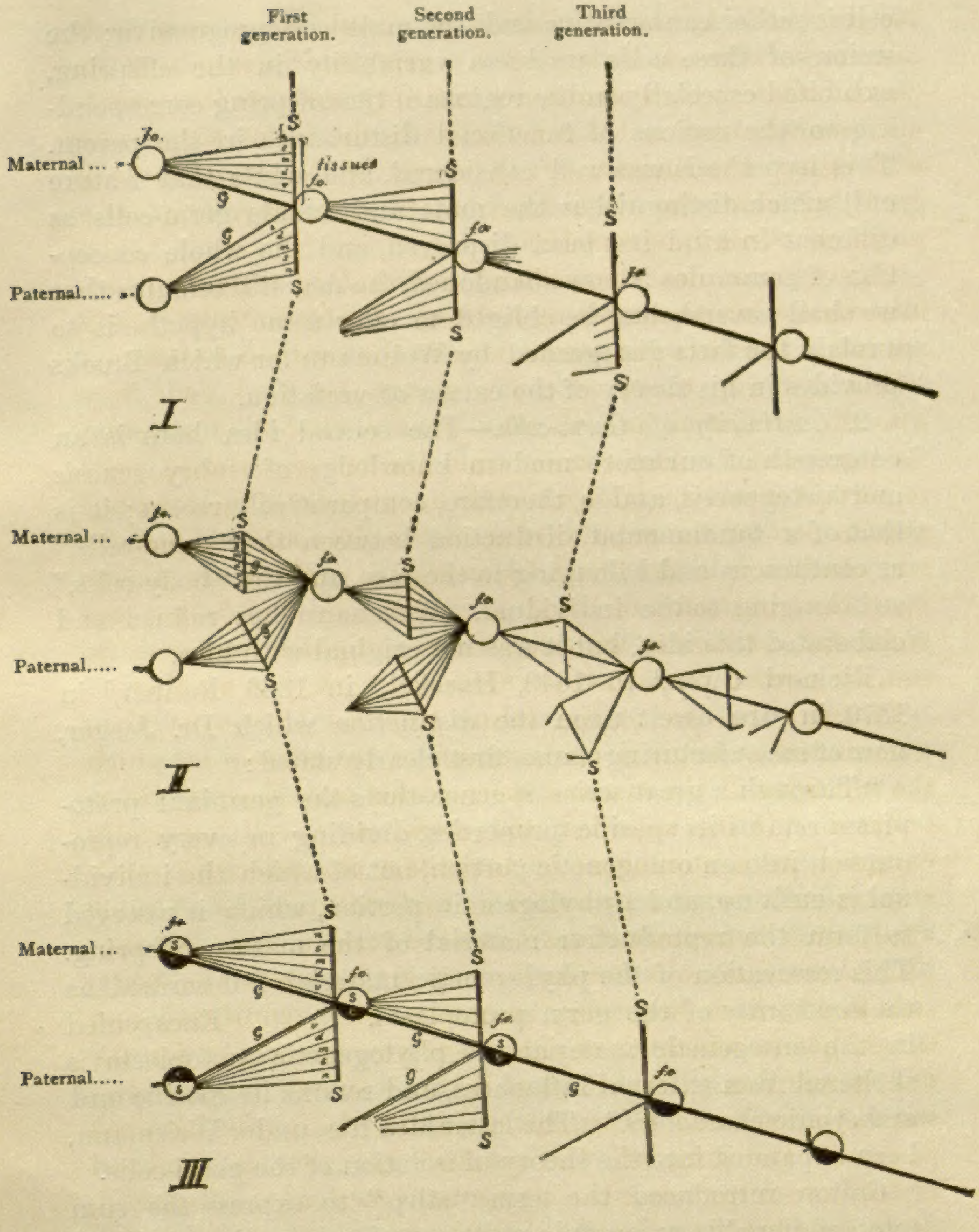
the germ-cells by the circulation of minute buds from each cell; each body-cell throws off a "gemmule" containing its characteristics; these gemmules multiply and become especially concentrated in the germ-cells; in the latter they unite with others like themselves; in course of development they grow into cells like those from which they were originally given off. (See Diagram II.)

Galton,[1] who has always been doubtful in regard to use-inheritance, while advancing a theory of "continuity," partly approved Darwin's pangenesis idea in the cautious statement: "Each cell may throw off a few germs that find their way into the circulation and thereby have a chance of entering the germ-cells." At the same time Galton contributed very important experimental disproof of the existence of "gemmules," and, in fact, of the popular idea, of the circulation of hereditary characters in the blood, by a series of careful experiments upon the transfusion of blood in rabbits; he found that the blood did not convey with it even the slightest tendency to transfer normal characteristics from one variety to another.

Professor Brooks,[2] of the Johns Hopkins University, then contributed an original modification of pangenesis in which the functions of the ova and spermatozoa were sharply differentiated. (1) He regarded the ovum as a cell especially designed as a storehouse of hereditary characteristics, each characteristic being represented by material particles of some kind; thus hereditary characters were handed down by simple cell division, each fertilized ovum giving rise to the body-cells in which its hereditary characters were manifested and to new ova in which these characters were conserved for the next generation (this portion of Brooks's theory is very similar to Galton's and Weismann's). 2. The body-cells have the power of throwing off "gemmules," but this is exercised mainly or exclusively when its normal functions are disturbed, as in metatrophic exercise or under change of environment. 3. These gemmules may enter the ovum, but the spermatozoan is their main center. According to this view the female

[1]Contemporary Review, vol. xxvii., p. 80–95.

[2]The Law of Heredity, 1883.



f. o., fertilized ovum or *embryo*, containing maternal and paternal characteristics; *S*, soma, or adult body, containing *n, s, m, d, v, somatic cells* of the various tissues; and *G*, *germ-cells* of the reproductive glands.

I. Histogenesis.—Showing the successive rise *G*, and union *f. o.* of the maternal and paternal germ-cells by direct histogenesis.

II. Pangenesis.—Showing the tissues of the body *S*, contributing to the germ-cells *G*, so that each *f. o.* is composed of elements from both the somatic and germ-cells.

III. Continuity.—Showing the division of the embryo, *f. o.*, into somatoplasm, *s* (from which arise the body-cells), and germ-plasm, *G* (which passes direct to the germ-cells), establishing a direct continuity.

cell is rather conservative and the male cell progressive; the union of these cells produces variability in the offspring, exhibited especially in the regions of the offspring corresponding to the regions of functional disturbance in the parent. This hypothesis was well considered, and while that feature of it which distinguishes the male and female germ-cells as different in kind has been disproved, and the whole conception of gemmules is now abandoned, the fact still remains that we shall nevertheless be obliged to offer some hypothesis to explain the facts disregarded by Weismann for which Brooks provides in his theory of the causes of variation.

2. *Continuity of Germ-cells.*—The central idea here is an outgrowth of our more modern knowledge of embryogenesis and histogenesis, and is, therefore, comparatively recent; it is that of a fundamental distinction between the "germ-cells," as continuous and belonging to the race, and the "body-cells," as belonging to the individual. Weismann has refined and elaborated this idea, but it was not original with him.

Richard Owen,[1] in 1849, Haeckel,[2] in 1866, Rauber,[3] in 1879, in turn dwelt upon the distinction which Dr. Jaeger, now of manufacturing fame, first clearly stated:

"Through a great series of generations the germinal protoplasm retains its specific properties, dividing in every reproduction into an ontogenetic portion, out of which the individual is built up, and a phylogenetic portion, which is reserved to form the reproductive material of the mature offspring. This reservation of the phylogenetic material I described as the continuity of the germ protoplasm. . . . Encapsuled in the ontogenetic material the phylogenetic protoplasm is sheltered from external influences, and retains its specific and embryonic characters." The latter idea has, under Weismann, been expanded into the theory of isolation of the germ-cells.

Galton introduced the term "stirp" to express the sum total of hereditary organic units contained in the fertilized ovum. His conception of heredity was derived from the

[1]See Parthenogenesis, in his Anatomy of Vertebrates.

[2]Generelle Morphologie, vol. ii., p. 170.

[3]Zool. Anz., vol. ix., p. 166.

study of man, and he supported the idea of continuity in the germ-cells in order to account for the law of transmission of "latent" characters; it is evident from this law that only a part of the organic units of the "stirp" become "patent" in the individual body; some are retained latent in the germ-cells, and become patent only in the next or some succeeding generation. For example, the genius for natural science was "patent" in Erasmus Darwin, grandfather of the great naturalist, it was "latent" in his son, and reappeared intensified in his grandson, Charles Darwin. I have elsewhere[1] summed up as follows Galton's general results, which so remarkably strengthen the "continuity" idea: We are made up, bit by bit, of inherited structures, like a new building, composed of fragments of an old one, one element from this progenitor, another from that, although such elements are usually transmitted in groups. The hereditary congenital constitution thus made up is far stronger than the influences of environment and habit upon it. A large portion of our heritage is unused, for we transmit peculiarities we ourselves do not exhibit. The contributions from each ancestor can be estimated in numerical proportions, which have been exactly determined, from statistics of stature in the English race; thus the contributions from the "patent" stature of the two parents together constitute one-half; while the contributions by "latent" heritage from the grandparents constitute one-sixteenth, etc. One of the most important demonstrations by Galton, is the *law of regression;* this is the factor of stability in race type which acts as gravitation does upon the pendulum; if an individual or a family swing far from the average characteristics of their race, and display exceptional physical or mental qualities, the principle of regression in heredity tends to draw their offspring back to the average.

Now how shall we distinguish regression from reversion? Very clearly, I think; *regression* is the short pull which tends to draw every variation and the individual as a whole back to the contemporary typical form, while *reversion* is the long pull which draws the typical form of one generation back to

[1] Atlantic Monthly, March, 1891, p. 359.

the typical form of a very much earlier generation. These forces are evidently akin, and in the shades of transition from one type to another we would undoubtly find a constant diminution numerically in the recurrence of characters of the older type, and thus "regression" would pass insensibly into "reversion."

Weismann has carried the idea of continuity to its extreme in his simple and beautiful theory of heredity, which is founded upon the postulate that there is a distinct form of protoplasm, with definite chemical and molecular properties, set apart as the vehicle of inheritance; this is the *germ-plasm, G,* quite separate from the protoplasm of the body-cells or *somatoplasm, S.* Congenital characters arising in the germ-cells are called *blastogenetic,* while acquired characters arising in the body-cells are *somatogenetic.*

To clearly understand this view, let us follow the history of the fertilized ovum in the formation of the embryo. It first divides into somatoplasm and germ-plasm (see Diagram III.), the former supplies all the tissues of the body—*n, s, m, d, v,* nervous, muscular, vascular, digestive, etc.—with their quota of hereditary structure; the residual germ-plasm is kept distinct throughout the early process of embryonic cell division until it enters into the formation of the nuclei of the reproductive cells, the ova or spermatozoa. Here it is isolated from changes of function in the somatoplasm, and in common with all other protoplasm is capable of unlimited growth by cell division without loss or deterioration of its past store of hereditary properties; these properties are lodged in the nucleus of each ovum and spermatozoan, and these two cells, although widely different in external accessory structure (because they have to play an active and passive part in the act of conjugation), are exactly the same in their essential molecular structure, and the ancestral characters they convey differ only because they come along two different lines of descent. When these cells unite they carry the germ-plasm into the body of another individual. Thus the somatoplasm of each individual dies, while the germ-plasm is immortal; it simply shifts its abode from one generation to another; it constitutes the

chain from which the individuals are mere offshoots. Thus the germ-plasm of man is continuous with that of all ancestors, in his line of descent, and we have an explanation of the early stages observed in development in which the human embryo passes through a succession of metamorphoses resembling the adult forms of lower types.

In order to emphasize, as it were, the passage of the germ-plasm from one generation to another without deterioration in its marvellous hereditary powers, Weismann added the idea of its *isolation*. Not only does he repudiate the pangenesis notion of increment of germ-plasm by addition of gemmules, but he believes that it is unaffected by any of the normal changes in the somatic or body-cells. As this continuity and isolation would render impossible the transmission of characters acquired by the somatoplasm, Weismann began to examine the evidence for such transmission, and coming to the conclusion that it was insufficient, in his notable essay on "Heredity," in 1883, he boldly attacked the whole Lamarckian theory and has continued to do so in all his subsequent essays.

Being forced to explain evolution without this factor, he claimed that variation in the germ-plasm was constantly arising by the union of plasmata from different lines of descent in fertilization, and that these variations are constantly being acted upon by Natural Selection to produce new types. He thus revived Darwin's earlier views of evolution, and this in part explains his strong support by English naturalists.

It will be seen at once that there are a number of distinct questions involved.

The matter of first importance in life is *the repetition and preservation of type*, the principle which insures the unerring accuracy and precision with which complex organs are built up from the germ-cells; the force of regression and the more remote forces of reversion all work in this conservative direction; the theory of the preservation of these forces in a specific and continous form of protoplasm is by far the most plausible we can offer at present. The matter of second importance, but equally vital to the preservation of races, in the long run, is *the formation of new types* adapted to new circumstances of

life. I shall now attempt to show that the facts of evolution, while not inconsistent with the idea of continuity of the germ-plasm, are wholly at variance with the idea of its independence, separation, or isolation from the functions of the body. This can be done by proving, first, that the theory of evolution solely by natural selection of chance favorable variations in the germ-plasm is inadequate; second, that the inheritance of definite changes in the somatic cells is also necessary to evolution, and therefore there must exist some form of force or matter which connects the activities of the somatoplasm with those of the germ-plasm.

In the following table are placed some of the facts of human evolution which we have observed in the first lecture, and as they are part of inheritance, they also constitute the main external phenomena of heredity:

Phenomena of Heredity.

Conservative (toward past type).	*Neutral.*	*Progressive* (toward future type).
a. Repetition of parental type.	Fortuitous	*a.* Definite Variation in single characters, by accumulation=.
	and	
b. Regression (in many characters) to contemporary race type.	Indefinite	*b.* Definite Variation in many characters (from contemporary race type).
c. Reversion (mainly in single characters) to past race type.	Variations.	

What are the causes of these various phenomena?

Factors of Evolution.—The term "kinetogenesis" has been applied to the modern form of the Lamarckian theory, for it is an application of kinetic or mechanical principles to the origin of all structures such as teeth, bone, and muscle. It would be fatal to this theory, if it could be shown that the

changes taking place in course of a normal individual life, under the laws of use and disuse, are inadaptive, or do not correspond to those observed in the evolution of the race.

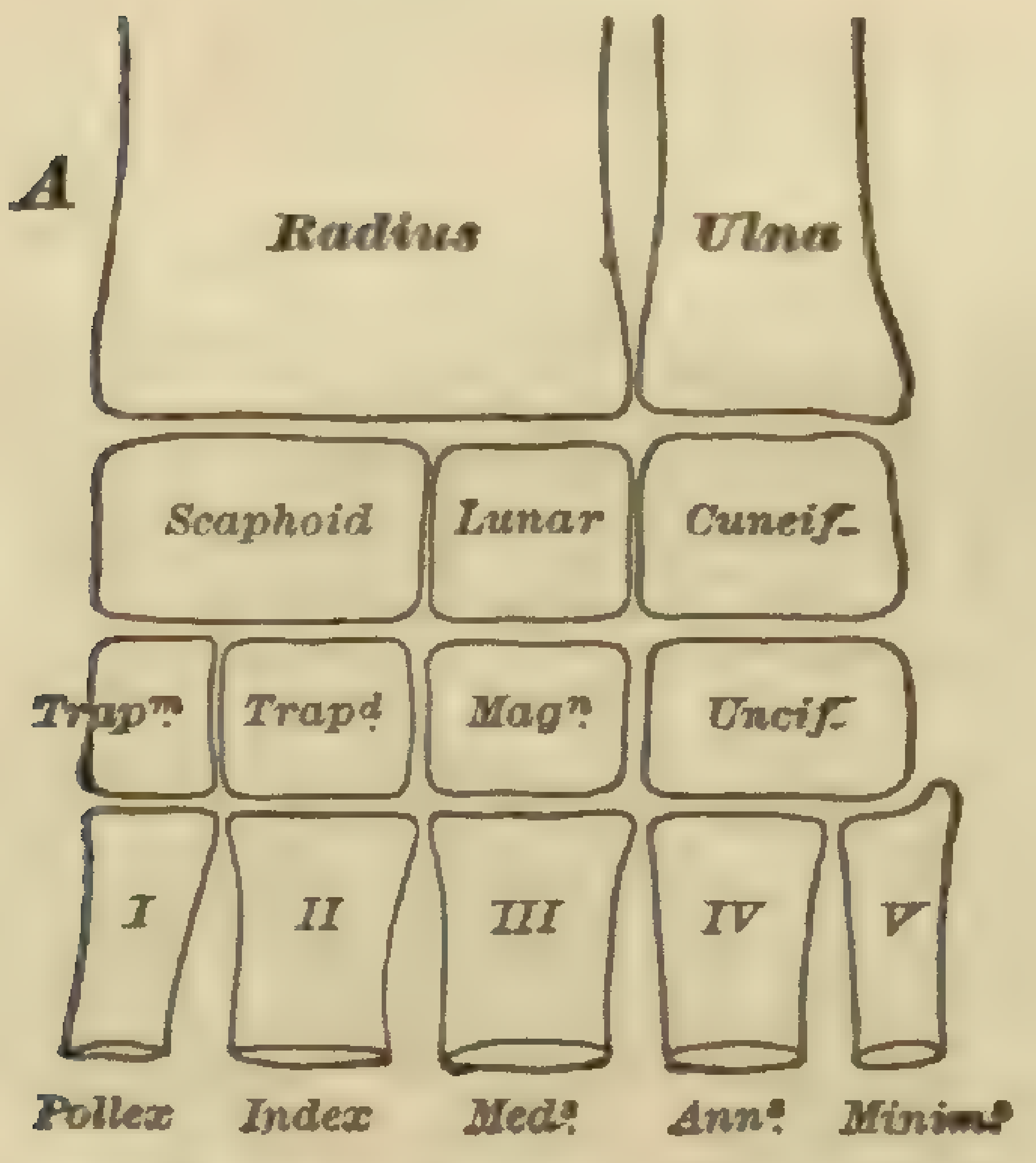
The Relative Growth of Organs.—Ball,[1] in his long argument against Lamarckianism, claims that such is the case, and that use-inheritance would be an actual evil: "Bones would often be modified disastrously. Thus the condyle of the human jaw would become larger than the body of the jaw, because as the fulcrum of the lever it receives more pressure. Some organs (like the heart, which is always at work) would become inconveniently or unnecessarily large. Other absolutely indispensible organs which are comparatively passive or are very seldom used would dwindle until their weakness caused the ruin of the individual or the extinction of the species." He later cites from Darwin[2] the "Report of the United States Commission upon the Soldiers and Sailors of the Late War," that the longer legs and shorter arms of the sailors are the reverse of what should result from the decreased use of the legs in walking and increased use of the arms in pulling. A little reflection on Mr. Ball's part would have spared us this crude exception, for whatever difficulties may arise from theoretical speculation as to the laws of growth, or from statistics, the fact remains that activity must increase adaptation in every part of the organism; otherwise the runner and the trotting horse should be kept off the track to increase their speed, the pianist should employ as little finger-exercise as possible. If the growth tendencies in single organs are transmitted, it is evident that the adaptive adjustments between these tendencies will also be transmitted.

The Feet.—In point of mechanical adaptation, man, with the single exception of his thumb and forearm, has not progressed beyond the most primitive eocene quadruped. The laws of evolution of the foot in the ungulate or hoofed animals, which have been especially studied by Kowalevsky, Ryder, Cope, and myself, afford a conclusive demonstration that the skeletal changes in the individual coincide with those which

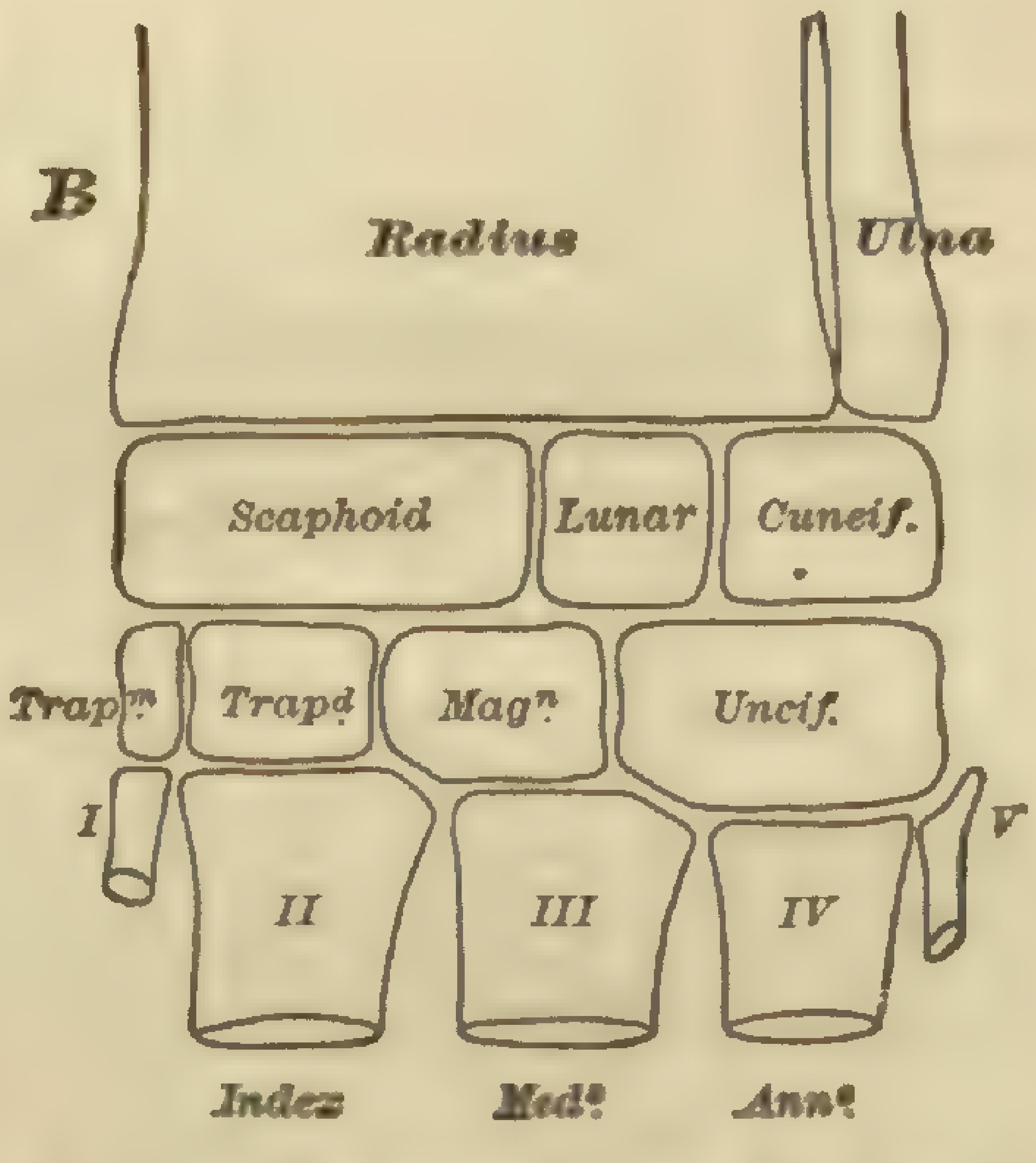
[1]Op. cit., p. 129.

[2]Descent of Man, p. 32.

will mark the evolution of the race. In the earliest ungulates the carpals and tarsals are disposed, as in man, directly above each other, with serial joints, as in *A*; in the course of evolution all these joints became interlocking, as in *B*, thus producing an alternation of joints and surfaces similar to those which give strength to masonry. In studying these facts Cope[1] reached a certain theory as to the motion of the foot and leg in locomotion. In trying to apply this, I found it could not be harmonized with all the facts, and I worked out an entirely different theory.[2] This I found subsequently coincided exactly with the results previously obtained by Muybridge, by the aid of instantaneous photographs, and summarized by Professor Harrison Allen, of the University of Pennsylvania.[3]



PRIMITIVE UNGULATE FOOT.—Lines of vertical cleavage on either side of the middle toe, III. Spreading of toes would cause separation of the carpals.



RECENT UNGULATE FOOT.—No lines of verticle cleavage. All joints broken by enlargement of scaphoid, unciform, and radius, the bones receiving greatest impact in walking. Lateral toes, I., V., degenerate.

The monodactylism of the horse was attained by the atrophy of the lateral toes, and concentration of the major axis of body-weight and strain upon the middle finger and toe. Man is also tending toward monodactylism in the foot

[1]AMERICAN NATURALIST, 1887, p. 986.

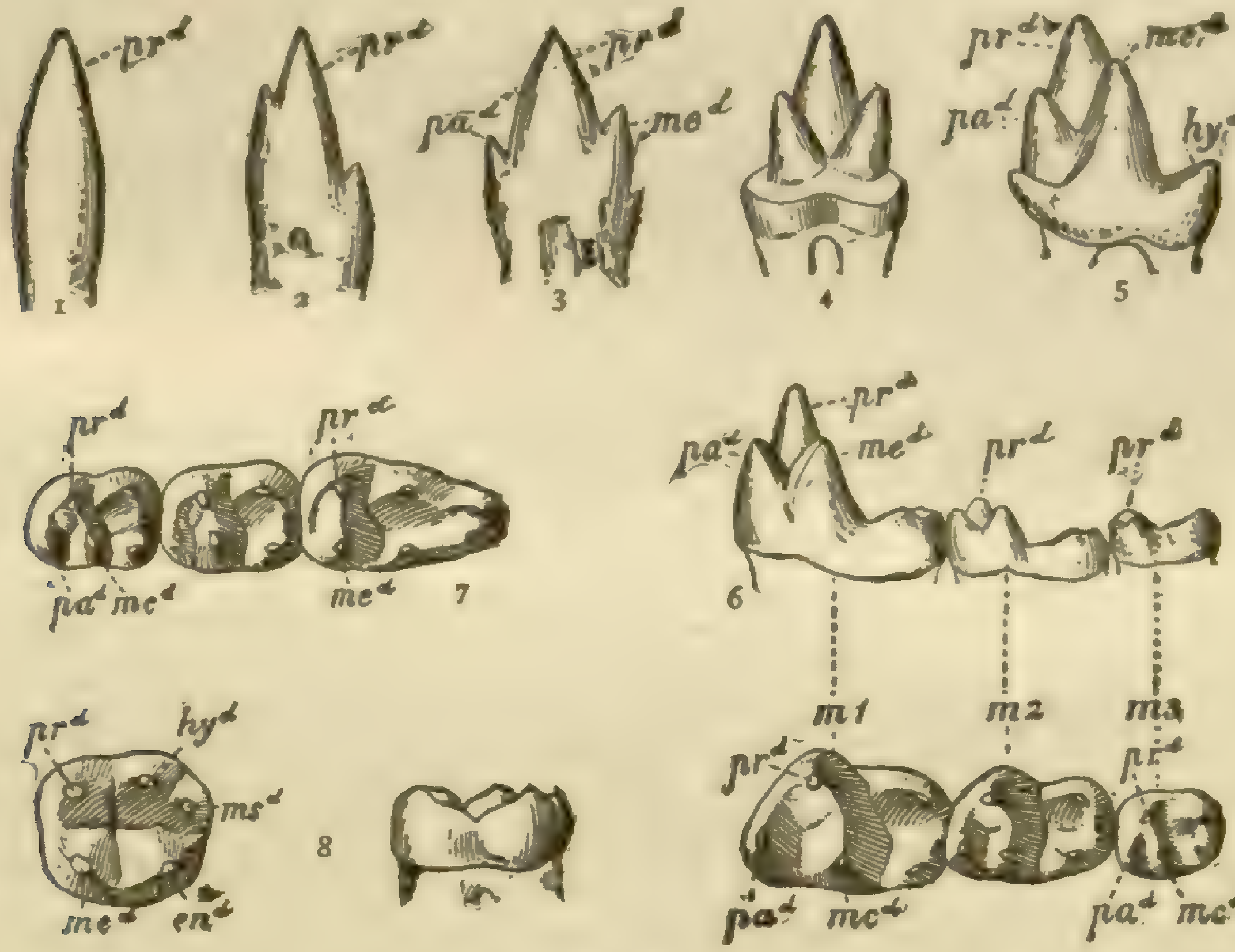
[2]See Trans. of American Philosophical Society, p. 561. Philadelphia, 1889.

[3]The Muybridge Work at the University of Pennsylvania. Philadelphia, 1888.

by the establishment of the major axis through the large toe and atrophy of the outer toes. The present atrophy of our small toe is as good a parallel as we can find of the changes which were occurring in the eocene period among the ancestors of the horse.

The Teeth.—But how about the teeth, in which there is an absolute loss of tissue in consequence of use? This is another objection raised by Ball, Poulton, and others which disappears upon examination.

The dental tissues, while the hardest in the body, and, unlike bone, incapable of self-repair, are not only both living and sensitive, but, to a very limited degree, plastic and capa-

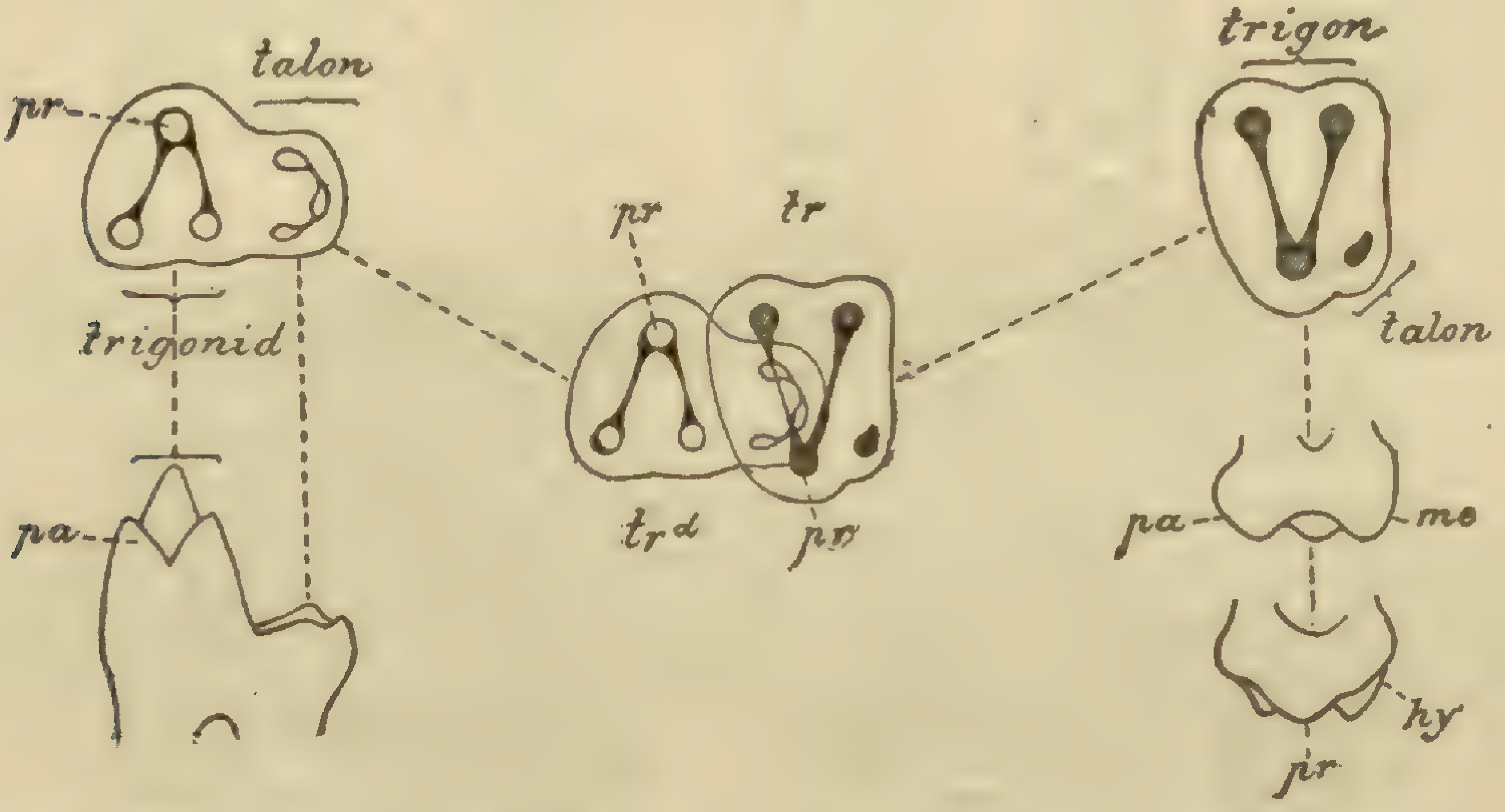


Evolution of the Cusps of the Human Lower Molar.—*prd*, protoconid (anterior buccal cusp); *pad*, paraconid; *med*, metaconid (anterior lingual cusp); *hyd*, hypoconid (posterior buccal); *end*, entoconid (posterior lingual cusp); *msd*, mesoconulid (intermediate cusp). Fig. 1.—Reptilian stage. Fig. 2-5.—Mesozoic mammals, first lower molars showing rise of ancestral cusps. Fig. 6.—Eocene carnivore (*Miacis*), showing how the low tubercular crown *m3* is derived from the high crown *m1*. Fig. 7.—Eocene monkey (*Anaptomorphus*), showing how the primitive anterior lingual cusp, *pad*, disappears. Fig. 8.—Human first molar with its ancestral cusps.

ble of change of form. *Ex hypothesi*, it is not the growth, but the reaction tendency which produces the growth, which is transmitted. The evolution of the teeth, therefore, falls into the same category as bone.[1] In the accompanying figures I

[1]See especially the papers of Ryder, Cope, and the writer, "Evolution of Mammalian Molars to and from the Tritubercular Type," American Naturalist, 1889.

have epitomized the slow transformation of the single-fanged conical reptilian tooth, such as we see in the serpents, into the low-crowned human grinder. We now know all the transition forms, so that we can homologize each of the cusps of the human molar with its varied ancestral forms in the line of descent. For example, the anterior lingual or inner cusp of the upper true molars traces its pedigree back to the reptilian cone. The anterior triangle of cusps, or trigon, seen in the mosozoic mammalia, and persisting in the first inferior true molar of the modern dog, is still seen in the main portion of the crown of the human upper molars (*pr*, *pa*, *me*). To this was added, ages ago, the posterior lingual cusp, or hypocone, which, as Cope has shown, is exhibited in various degrees of development in different races and is an important race



Lower molar. Upper and lower molars opposed. Upper molar.

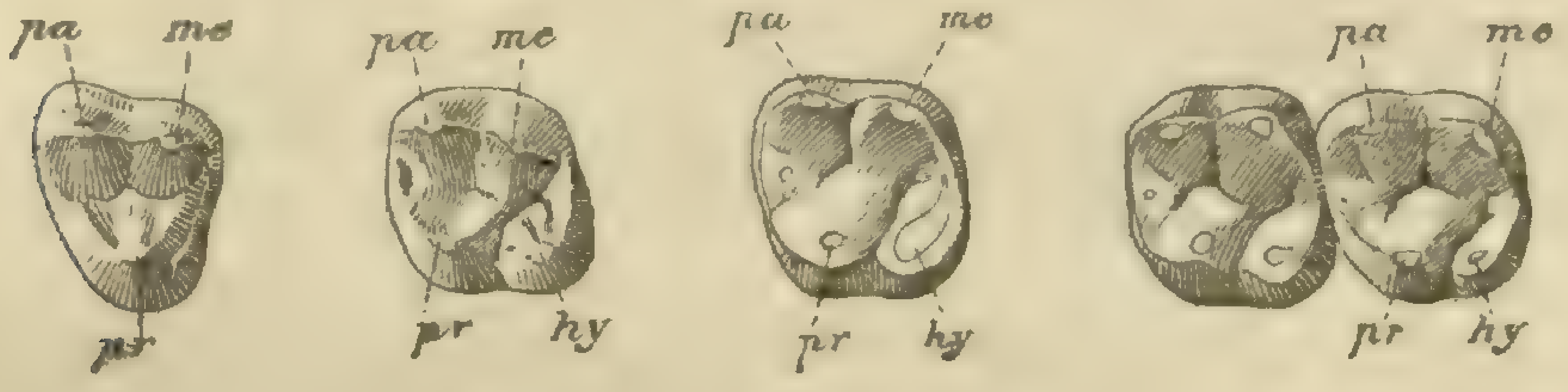
Key to Plan of Upper and Lower Molars in all Mammals.—Each tooth consists of a triangle, *trigon*, with the protocone, *pr*, at the apex. The apex is on the inner side of the upper molars and on the outer side of the lower molars.

index.[1] A glance through the diagrams shows that the development of the crown has been by the successive addition of new cusps. Without entering upon the details of evidence which would be out of place here, I may say briefly that the new main cusps have developed at the points of maximum

[1]The upper molars in many Esquimaux are triangular (as in Fig. 11); in most negroes they are square (Fig. 12). In our race they are intermediate.

wear (*i. e.*, use), and conversely in the degeneration of the crown, disuse foreshadows atrophy and disappearance.

Upon the whole, with some exceptions which we do not at present understand, the course of evolution of the teeth supports the evidence derived from the skeleton, that, whether any true causal relation has existed or not, the lines of individual transformation in the whole fossil series preceded those of race transformation.



EVOLUTION OF THE HUMAN UPPER MOLARS.—Fig. 9.—*Anaptomorphus*, a lower eocene monkey. Fig. 10.—An upper eocene monkey. Fig. 11 and 12.—Human, 11, Esquimaux; 12, negro. See addition of "talon," *hy*, to "trigon" composed of *pa*, *pr*, *me*.

The Rise of New Organs.—We owe to Dr. Arbuthnot Lane a most interesting series of studies upon the influences of various occupations upon the human body. He proves conclusively that individual adaptation not only produces profound modifications in the proportions of the various parts, but gives rise to entirely new structures.

His anatomy and physiology of a shoemaker[1] shows that the lifelong habits of this laborious trade produce a distinct type, which if examined by any zoological standard would be unhesitatingly pronounced a new species—*homo sartorius.* The psychological analysis which a Dickens or Balzac would draw, showing the influences of the struggle for existence upon the spirit of this little tailor could not be more pathetic than Dr. Lane's analysis of his body. The bent form, the crossed legs, thumb and forefinger action, and peculiar jerk of the head while drawing the thread, are the main features of sartorial habit. The following are only a few of the results: The muscles tended to recede into tendons and the bony surfaces into which they were inserted tended to grow in the

[1]Journal of Anatomy and Physiology, 1888, p. 595.

direction of the traction which the muscle exerted upon them. The articulation between the sternum and the clavicle was converted into a very complex arthrodial joint, constituting almost a ginglymoid articulation. The sixth pair of ribs were anchylosed to the bodies of the vertebræ, indicating that they had ceased to rise and fall with sternal breathing, and that respiration was almost exclusively diaphragmatic. The region of the head and first two vertebræ of the neck was still more striking: the transverse process of the right side of the atlas, toward which the head was bent, formed a new articulation with the under-surface of the jugular process of the occipital bone, "a small synovial cavity surrounded this acquired articulation, but there was no appearance of a capsular ligament;" the left half of the axis was united by bone to the corresponding portion of the third cervical; there was found a new upward prolongation of the odontoid peg of the axis, and a new accessory transverse ligament to keep it from pressing upon the cord. In short, "the anatomy of the shoemaker represents the fixation and subsequent exaggeration of the position and tendencies to change which were present in his body when he assumed the position for a short period of time.

Rate of Inheritance.—This illustration serves also to emphasize the great contrast between the rapidity of individual transformation and the slowness of race transformation. No one would expect the son of this shoemaker to exhibit any of these acquired malformations. Yet Dr. Lane thinks he has observed such effects in the third generation by the summation of similar influences.

All palæontological evidence goes to show that the effects of normal habits, if transmitted at all, would be entirely imperceptible in one generation. The horse, for example, has not yet completely lost the lateral toes which became useless at the end of the upper eocene period. This objection as to rate of evolution may be urged with equal force against the natural-selection theory. It is obvious that the active progressive principle in evolution, whatever it is, must contend with the enormous conservative power of inheritance, and

this, to my mind, is one of the strongest arguments against the possibilities of the rise of adaptive organs by the selection of chance favorable variations in the germ-plasm.

Application to Human Evolution.—Principles underlying these illustrations may now be applied to some of the facts in human evolution brought out in the first lecture. They show that if functional tendencies are transmitted we can comprehend the distinct evolution history of each organ; the rise and fall of two organs side by side; the definite and purposive character of some anomalies; the increase of variability in the regions of most rapid evolution; the correlation of development, balance and degeneration in the separate organs of the shoulder, hand and foot.

Yet even granting this theory, there still remain difficulties. The relation of use and disuse to some of the contemporary changes in the human backbone is rather obscure. I would hesitate to pronounce an opinion as to whether our present habits of life are tending to shorten the lumbars, increase the spinal curvatures, and shift the pelvis, without making an exhaustive study of human motion. Among the influences which Dr. Lane has suggested[1] as operative here are the wearing of heeled shoes and the increase of the cranium. He considers the additional or 6th lumbar vertebra as a new element rather than as a reversion, and works out in some detail the mechanical effects of the presence of the fœtus upon female respiration (*i.e.*, in the sternal region) and upon the pelvis. Now, if it be true that the female pelvis is relatively larger in the higher races than in the lower, I do not think that Dr. Lane can sustain his point, because in the lower races the fœtus is carried for an equally long period, during a much more active life, and in a more continuously erect position. Therefore, if these mechanical principles were operating, the pelvis in the modern lower races should be larger than in the higher. On the other hand, the form of the female pelvis in the higher races is one of the best established selecting or eliminating factors, a large pelvis favoring frequent births

[1]Journal of Anatomy and Physiology, 1888, p. 219.

and the preservation of those family stirps in which it occurs. I mention this to show how cautious we must be in jumping to conclusions as to kinetogenesis.

The transformism in all the external features of the skull, jaws, and teeth may be attributed to inherited tendencies toward hypertrophy or atrophy; but how about the convolutions of the turbinal bones or the complex development of the semicircular canals and cochlea of the internal ear and the many centers of evolution which are beyond the influences of use and disuse? These are examples of structures which fortify Weismann's contention, for if complex organs of this character can only be accounted for by natural selection, why consider selection inadequate to account for all the changes in the body?

Difficulties in the Natural-Selection Theory.—The answer, I think, is readily given: We do not know whether use and disuse are operating upon the mechanical construction of the ear; we do know that the organ can be rendered far more acute by exercise; but even if it were true that habit can exert no formative influence, the ear is one of those structures which since its first origin has been an important factor in survival, and *may* therefore have been evolved by natural selection. Now the very fact that selection may have to care for variations in such prime factors in survival as the ear, renders it the more difficult to conceive that it also is nursing the minutiæ of variation in remote, obscure, and uncorrelated organs.

Even in the brief review of human evolution in the first lecture I have pointed out eight independent regions of evolution, upward of twenty developing organs, upward of thirty degenerating organs. A more exhaustive analysis would increase this list tenfold. Now, where chance variation should produce an increase in size in all the developing organs, and a decrease in size of all the degenerating organs, and an average size in all the static organs, we would have all the conditions favoring survival. But the chances are infinity to one against such a combination occurring unless the tendencies of variation are regulated and determined, as

Lamarckians suppose, by the inheritance of individual tendencies. But may not the favorable variations in the body be grouped to either outweigh or underweigh the unfavorable variations? This would be possible if combinations occurred, but we can readily see that combinations, such as we observe in the separate elements in the foot alone, completely neutralize each other so far as "survival" is concerned; how the foot would neutralize the hand, or the foot and hand would neutralize the lumbar region.[1]

It is this consideration of single organs, the observation of their independent history, the rise of new compound organs, by steady growth from infinitesimal beginnings of their separate elements, the combined testimony of anatomy and palæontology which force us to regard the theory of evolution by the natural selection of chance variations as wholly untenable. With the utmost desire to regard the discussion in as fair a spirit as possible, the explanations offered by the adherents of Weismann's doctrine strike me as strained, evasive, and illogical.[2]

We can, however, by no means undervalue or dispense with natural selection, which must be in continuous operation upon every character of sufficient importance to weigh in the scale of survival. I need hardly remind you that this selecting principle was first discovered in 1813 by Dr. W. C. Wells, of Charleston, in connection with the immunity from certain tropical diseases enjoyed by negroes and mulattoes.[3]

The eliminating factor in selection is illustrated almost daily in cases of appendicitis. I regret I have not had time to ascertain whether or not this disease is considered due purely to accident or to congenital variation in the aperture of the appendix, which favors the admission of hard objects. If so, modern surgery is only benefiting the individual to the detriment of the race by its efficient preventive operations;

[1] I have expanded this idea fully in recent papers upon the theory of evolution of the horse. See "Are Acquired Variations Inherited?" AMERICAN NATURALIST, February, 1891.

[2] See Weismann's last essay, Retrogressive Development in Nature, Biol. Mem., trans., in press.

[3] See Introduction of Darwin's Origin of Species.

and every individual who succumbs to this disease can reflect with melancholy satisfation that he does so *pro bono publico.*

Conclusions as to the Factors of Evolution.—The conclusions we reach from the study of the muscular and skeletal systems are therefore as follows: 1st. That individual transformism in the body is the main determinant of variations in the germ-cells, and is therefore the main cause of definite progressive or retrogressive variations in single organs. 2d. That evolution in these organs is hastened, where all members of the race are subject to the same individual transformism. The contrast between the rate of individual transformism and race transformism is due to the strong conservative forces of the germ-plasma. 3d. That evolution is most rapid where variations are of sufficient rank to become factors in survival. Then selection and use-inheritance unite forces, as active progressive principles opposing the conservative principle in the germ-plasma. 4th. That fortuitous and chance variations also arise from disturbances in the body or germ-cells; they may be perpetuated, or disappear in succeeding generations.

Applying these views to variation there should, theoretically, appear to be just those two distinct classes of anomalies in the human body which we have seen actually occurring. First, those in the path of evolution, arising from perfectly normal changes in the somatoplasm and germ-plasm. Second, those wholly unconnected with the course of evolution, arising fortuitously or from abnormal changes in the somatoplasm or germ-plasm; to this head may be attributed the whole scale of deformities. Thus transformism and de-formism should be kept distinct in our minds. Nevertheless the facts of de-formism contribute the strongest body of evidence which we can muster at present to prove that there does exist a relation between the somatoplasm and germ-plasm which renders transformism possible.

The Relations between the Somatoplasm and Germ-plasm.—We have seen reasons to take a middle ground as to the distinct specific nature of the body cells and germ cells, and this position is, I think, strengthened the more broadly

we extend our inquiry into all the fields of protoplasmic activity.

There are three questions before us.

1. What is the evidence that the germ-plasm and somatoplasm are distinct?

2. What is the specific nature of the germ-plasm?

3. What is the nature of the relations which exist between the two?

1. The *separation of the germ-plasm* is in the regular order of evolution upon the principles of physiological division of labor. The unicellular organisms combine all the functions of life in a single mass of protoplasm, that is, in one cell. In the rise of the multicellular organisms the various functions are distributed into groups of cells, which specialize in the perfecting of a single function. Thus the reproductive cells fall into the natural order of histogenesis, and the theory of their entire separation is more consistent with the laws governing the other tissues than the theory which we find ourselves obliged to adopt, that while separate they are still united by some unknown threads with the other cells.

The morphological separation of what we may call the race-protoplasm becomes more and more sharply defined in the ascending scale of organisms. Weismann's contention as to the absolutely distinct specific nature of the germ-plasm and somatoplasm has, however, to meet the apparently insuperable difficulty that in many multicellular organisms, even of a high order, the potential capacity of repeating complex hereditary characters, and even of producing perfect germ-cells, is widely distributed through the tissues.

For example, cuttings from the leaves of the well-known hot-house plant, the begonia, or portions of the stems of the common willow-trees, are capable of reproducing complete new individuals. This would indicate either that portions of the germ-plasm are distributed through the tissues of these organisms, or that each body-cell has retained its potential quota of hereditary characters.

Among the lower animals we find the same power; if we cut a hydra or bell-animalcule into a dozen pieces each may

reproduce a perfect new individual. As we ascend in the animal scale the power is confined to the reproduction of a lost part in the process known as recrescence. As you well know, in the group to which the frog and salamander belong, a limb or tail, or even a lower jaw may be reproduced. The only logical interpretation of these phenomena is that the hereditary powers are distributed in the entire protoplasm of the organism, and the capacity of reproduction is not exhausted in the original formation of the limb, but is capable of being repeated. There has been considerable discussion of late as to the seat of this power of *recrescence.* It seems to me not impossible that in the vertebrates it may be stored in the germ-cells, and it would be very interesting to ascertain experimentally whether removal of these cells would in any way limit or affect this power; we know that such removal in castration or ovariotomy sometimes profoundly modifies the entire nature of the organism, causing male characters to appear in the female, and female characters to develop in the male.

So far as man is concerned it has been claimed by surgeons that genuine recrescence sometimes occurs; for example, that a new head is formed upon the femur after exsection; but my friend Dr. V. P. Gibney informs me that this is an exaggeration, that there is no tendency to reproduce a true head, but that a pseudo-head is formed which may be explained upon the principle of regeneration and individual transformism by use of the limb.

Pflüger's opinion is that recrescence does not indicate a storage of hereditary power, that there is no pre-existing germ of the member, but that the re-growth is due to the organizing and distributing power of the cells at the exposed surface, so that as new formative matter arrives it is built up gradually into the limb. This view would reduce recrescence to the level of the *regeneration* process, which unites two cut sections of the elements of a limb in their former order. It is partly opposed to the facts above referred to, which seem to prove the distribution of the hereditary power. Yet it seems to me quite consistent to consider these three processes—*a*, reproduction of a new individual from every part; *b*, recrescence of a new

member from any part; *c*, regeneration of lost tissues—as three steps indicating the gradual but not entire withdrawal of the reproductive power into the germ-cells.

I have not space to consider all the grounds which support the view of the separation of the germ-cells in man. Some of the more prominent are the very early differentiation of these cells in the embryo, observed with a few exceptions in all the lower orders of animals, and advancing so rapidly in the human female that several months before birth the number of primordal ova is estimated at seventy thousand, and is not believed to be increased after the age of two and a half years. The most patent practical proof is that we may remove every portion of the body which is not essential to life and yet the power of complete reproduction of a new individual from the germ-cells is unimpaired. Among the many reasons advanced for pensioning the crippled soldiers of our late war you never hear it urged that their children are incapacitated by inheritance of injuries. The strongest proof, however, rests in the evidence I have already cited from heredity of the extraordinary stability of the germ-cells, which is the safeguard of the race.

2. The *specific nature of the germ-plasm* must be considered before we consider its relations. Wherein lies the conservative power of the germ-plasm, and in what direction shall we look for its transforming forces? You see at once that marvellous as is the growth of cells in other tissues, the growth of the germ-cell is still more so.

We find it utterly impossible to form any conception of the contents of the microcosmic nucleus of the human fertilized ovum, which is less than $\frac{1}{2500}$ of an inch in diameter, but which is, nevertheless, capable of producing hundreds of thousands of cells like itself, as well as all the unlike cells of the adult organism. We can only translate our ideas as to the possible contents of this nucleus in the terms of chemistry and physics.[1]

Spencer[2] assumed an order of molecules or units of proto-

[1]See Ray Lankester, Nature, July 15, 1876.

[2]Principles of Biology, vol. i, p. 256.

plasm lower in degree than the visible cell-units, to the internal or polar forces of which and their modification by external agencies and interaction, he ascribes the ultimate responsibility in reproduction, heredity and adaptation. This idea of biological units seems to me an essential part of any theory; it is embodied in Darwin's "gemmules," in Haeckel's "plastidules," yet, as Lankester says, the rapid accumulation of bulk is a theoretical difficulty in the material conception of units. In the direction of establishing some analogy between the repetition power of heredity and known function of protoplasm, Haeckel[1] and Hering[2] have likened heredity to memory, and advanced the hypothesis of persistence of certain undulatory movements; the undulations being susceptible of change and therefore of producing variability, while their tendency to persist in their established harmony is the basis of heredity. Berthold, Gautier and Geddes[3] have speculated in the elaboration of the idea of metabolism; the former holding the view that "inheritance is possible only upon the basis of the fundamental fact that in the chemical processes of the organism the same substances and mixtures of substances are reproduced in quantity and quality with regular periodicity."[4]

I have merely touched upon these speculations to show that the unknown factors in heredity are also the unknown factors in operation in living matter. All we can study is the external form and conjecture that this form represents matter arranged in a certain way by forces peculiar to the organism. These forces are exhibited or patent in the somatic cells; they are potential or latent in the germ-cells.

The last stage of our inquiry is as to the mode in which the action of habit or environment upon the somatic cells can be brought to bear upon the germ-cells.

[1]Perigenesis der Plastidule oder die Wellenzeugung der Lebenstheilchen. Jena, 1875.

[2]Ueber d. Gedächtniss als eine allgemeine Function d. organischen Materie. Vienna, 1870.

[3]See also Thomson, op. cit., p. 102.

[4]Berthold: Studien über Protoplasma-Mechanik. Leipzig, 1886.

The Nature of the Relation Between the Body-cells and Germ-cells.—I have already shown that we are forced to infer that such a relation exists by the facts of evolution, although these facts show that the transmission of normal tendencies from the body to the germ-cells is ordinarily an extremely slow process.

Virchow[1] says every variation in race character is to be traced back to the pathological condition of the originator. All that is pathological is not diseased, and inheritance of a variation is not from the influence upon one individual necessarily, but upon a row of individuals. This is in the normal condition of things. In the abnormal condition the rate of transmission may be accelerated.

Does this transmission depend upon an interchange of material particles or upon an interchange of forces, or both?

There are three phenomena about which there is much scepticism, to say the least, which bear upon the question of a possible interchange of forces between the body and germ-cells. These are the inheritance of mutilations, the influence of previous fertilization, and the influence of maternal impressions. They are all in the quasi-scientific realm, which embraces such mental phenomena as telepathy. That is, we incline to deny them simply because we cannot explain them.

Mutilations.—Since the publication of Weismann's essays the subject of inherited mutilations has attracted renewed interest. I would first call attention to the fact that this matter has only an indirect bearing, for a mutilation is something impressed upon the organism from without; it is not truly "acquired;" the loss of a part by accident produces a sudden but a less profound internal modification of the organism than the loss of a part by degeneration. Most of the results are negative; many of the so-called "certain" cases prove upon investigation to be mere coincidences. Weismann[2] himself experimented upon white mice, and showed that nine hundred and one young were produced by five generations of arti-

[1]Ueber den Transformismus, Archiv f. Anthropologie, 1888, p. 1.

[2]Biological Memoirs, p. 432.

ficially mutilated parents, and yet there was not a single example of a rudimentary tail or of any other abnormality in this organ. The cases of cleft ear lobule have recently been summed up.[1] Israel reports two cases of clefts in which the parent's ears were normal. Schmidt and Ornstein report affirmative cases. His shows that an affirmative case, cited by V. Zwieciki, is merely an inherited peculiarity. The entire evidence is unsatisfactory, and upon the whole is decidedly negative.

Not so, however, in cases where the mutilation results in a general disturbance of the normal functions of different organs, as in the experiments conducted by Brown-Séquard[2] upon guinea-pigs, in which we see "acquired variation" intensified. In these, abnormal degeneration of the toes, muscular atrophy of the thigh, epilepsy, exophthalmia, etc., appeared in the descendants of animals in which the spinal cord or sciatic nerve had been severed, or portions of the brain removed. It was also shown that the female is more apt to transmit morbid states than the male; that the inheritance of these injuries may pass over one generation and reappear in the second; that the transmission by heredity of these pathological results may continue for five or six generations, when the normal structure of the organs reappears. These cases, which are incontestable, at first sight appear to establish firmly the transmission of acquired characters; they were so regarded by Brown-Séquard. These lesions act directly upon the organs, and the abnormal growth in these organs appears to be transmitted. But can they not be interpreted in another way, namely, that the pathological condition of the nerve-centers has induced a direct disturbance in those portions of the germ-cells which represent and will develop into the corresponding organs of the future offspring?

Previous Fertilization.—Consider next the influence exerted upon the female germ-cell by the mere proximity of the male

[1] Journal of Anatomy and Physiology, 1891, p. 433.

[2] Comptes-Rendus, March 13, 1882. These experiments have been confirmed by Obersteiner.

germ-cell, as exhibited in the transmission of the characteristics of one sire to the offspring of a succeeding sire observed in animals, including the human species, also in plants. The best example is the oft-quoted case of Lord Morton's mare, which reproduced in the foal of a pure Arab sire the zebra markings of a previous quagga sire.

Some physiologists[1] have attempted to account for these remarkable indirect results from the previous fertilization or impregnation, by the imagination of the mother having been strongly affected or from interchange between the freely intercommunicating circulation of the embryo and mother, but the analogy from the action in plants (in which there is no gestation but early detachment and development of the fertilized cells) strongly supports the belief that the proximity of male germ-cells acts directly upon the female cells in the ovary. All that we can deduce from these facts is that in some manner the normal characteristics and tendencies of the ova are modified by the foreign male germ-cells without either contact or fertilization.

Maternal Impression.—The influence of maternal impressions in the causation of definite anomalies in the fœtus is largely a matter of individual opinion.

It is denied by some high authorities, led by Bergman and Leuckart.[2] Most practitioners, however, believe in it, and I need hardly add that it is a universal popular belief,[3] supported by numerous cases. I myself am a firm believer in it, from evidence which I am not free to publish. The bearing which the subject has upon this discussion is this: if a deviation in the development of a child is produced by maternal impression we have a proof that a deviation from normal hereditary tendencies can be produced without either direct vascular or nervous continuity.

We see an analogy between the experiments of Brown-Séquard, the influence of the previous sire, and the maternal

[1]See the cases cited by Ribot and Darwin: Animals and Plants under Domestication, vol. i, p. 437.

[2]Handwörterbuch der Physiologie, Wagner, Artikel "Zeugung," Leuckart.

[3]See Medical Record, October 31, 1891, an article by Joseph Drzewiecki, M. D.

influence. Neither, in my opinion, directly supports the theory of transmission of acquired characters, for they do not prove that normal changes in the body-cells directly react upon the germ-cells; they all show that the *typical hereditary development of single organs may be diverted by living forces which have no direct connection* with them according to our present knowledge.

What the nature of these forces is I will not undertake to say, but I believe we must admit the existence of some unknown force, or rather of some unknown relations between the body-cells and germ-cells.

A year ago, recognizing fully the difficulty of advancing any theory of heredity which would explain the transmission of acquired characters, I came to the following result: "It follows as an unprejudiced conclusion from our present evidence that upon Weismann's principle we can explain inheritance but not evolution, while with Lamarck's principle and Darwin's selection principle we can explain evolution, but not, at present, inheritance. Disprove Lamarck's principle and we must assume that there is some third factor in evolution of which we are now ignorant."

In this connection it is interesting to quote again from my colleague, Professor E. B. Wilson. He writes that the tendency in Germany at present is to turn from speculation to empiricism, and this is due partly "to the feeling that the recent wonderful advances in our knowledge of cell phenomena have enormously increased the difficulties of a purely mechanico-physical explanation of vital phenomena. In fact, it seems that the tendency is to turn back in the direction of the vital-force conception. . . . As Boveri said to me recently, 'Es gibt zu viel Vorstand in der Natur um eine rein mechanische Erklärung der Sache zu ermöglichen.'"

In the final lecture we turn to the forces exhibited in the germ-cells.

Note.—Bearing upon the experimental evidence for the hereditary transmission of multilations, I have recently received, through Dr. Charles E. Lockwood, of New York, a letter,[1] in regard to some experiments upon mice, which were continued over more generations than those of Weismann, and with affirmative results:

"I selected a pair of white mice on account of their rapid breeding. I bred them in and in for ninety six generations, as they breed every thirty days, and when they are thirty days old they are able to reproduce themselves. I destroyed all sickly and defective ones by breeding only the fittest. I bred all disease out of them, and had a pure-blooded animal, larger and finer every way than the original pair. In breeding their tails off, I selected a pair and put them in a cage by themselves, and when they had young I took the young and clipped their tails off. When old enough to breed I selected a pair from the young and bred them together, and when they had young I clipped their tails. I continued this breeding in and in, clipping each generation, and selecting a pair of the last young each time, in seven generations. Some of the young came without tails until I got a perfect breed of tailless mice. I then took one with a tail and one without a tail and bred them together, and by changing the sexes each time—a male without a tail, a female with a tail, and next a female without a tail, and a male with a tail—I was finally rewarded with all-tail mice."

There is such general scepticism now in regard to the inheritance of mutilations that it will be necessary to repeat such experiments as these in some well-known physiological laboratory. As told above, they seem to be trustworthy, but facts which go against a theory must be doubly attested.

[1]From A. J. S. Shiddell, Lexington, Ky.

SUPPLEMENTARY INVESTIGATION AT TICK ISLAND.

By Clarence Bloomfield Moore.

In the February, 1892, number of the American Naturalist, I gave an account of certain investigations made by me at Tick Island, Volusia Co., Florida. The readers of that article will recall that into the great sand mound at that place numerous trenches and shafts were made, resulting in the discovery of a number of objects of interest archæologically, and the formation by me of a theory as to the construction of the mound. This theory has not in any way been modified by a supplementary investigation continued with a party of seven assistants through January 15th, 16th, 18th, 19th, 1892.

The mound is built upon a circular heap of shell converging to an apex at the center. This heap was probably brought from neighboring shell deposits or a low heap already formed was used for the purpose. I am inclined to believe, however, that the shell was brought with a view to the formation of a solid base in the swamp, since irregular ridges and elevations of shell do not extend beyond the margin of the mound as is so often the case where sand mounds have been piled upon previously existing shell heaps. It will be remembered that a ridge of pure white sand with sloping ends ran north and south almost through the mound, this ridge being covered with brown sand having at times a certain admixture of shell, and that this covering of brown sand, comparatively small at the extremities of the ridge, attained great thickness on its sides to the east and west thus completing the conical shape of the mound.

On the western side of the mound, beginning at the margin of the base, was made a diverging trench, 8 ft. in breadth at the start, 54 ft. in length, or 4 ft. beyond the center of the mound. At 44 ft. from the starting point the breadth of the trench was 14 ft. and its depth 10 ft. From this point to the end the breadth of 14 ft. was maintained to a depth of 6 ft.

and two inches through the brown sand and converging to a width of 10 ft. through the white sand. No effort was made to penetrate the compact mass of shell at the base of the mound save at one or two points, where the usual debris of the shell heaps was found. The trench, when digging was discontinued (having followed the upward slope of the shell base) was 11 ft. and 10 in. in depth, of which the white sand above the shell was 5 ft. 8 in. and the upper layer or brown sand 6 ft. and 2 in., leaving to the shell base a thickness of 5 ft. and 5 in. above the level of the margin of the base of the mound.

At a distance of 30 ft. from the start the side of the white sand ridge was encountered, the trench up to that point running through the brown sand layer. The first skeleton was met with 24 ft. from the beginning of the trench. Previous to this many bones entirely disconnected, and mainly the larger bones of the skeleton, were found. With the exception of the articular portions the bones were not affected by decay to a marked extent as were those subsequently found covered by the white sand. It is possible that they are of a later period or that the lime salts from the admixture of shell have contributed to their preservation. As before stated these bones were not in association with each other but must not be confounded with the form of burial practiced on the east and west coasts of Florida and in at least one mound on the St. John's, namely Ginn's Grove, south of Lake Monroe, where piles of larger bones previously exposed were found buried horizontally surmounted by the skulls. Neither were the bones in any way crushed, split or charred, suggestive of the methods of many of the shell heaps of the St. John's River, nor did they show any signs of the breakage of necessity occurring when decayed bones are disturbed by the aid of implements. In the plateau constituting the summit of the mound were flexed burials (probably intrusive) in anatomical order and others were numerous on the slope bordering the plateau. Unless the disconnected bones were washed down when the mound was larger and not as at present held compactly together by the roots of vegetation, I can form no hypothesis to offer as to their condition when found.

In the white sand ridge as before, lying upon the shell base, were found burials in anatomical order, while differing from our former investigation some interments were met with in the white sand considerably above the shell.

Owing to decay and to the pressure of sand no crania were saved though great pains were taken and preservative agents were at hand. In this connection I may say that from seventeen burial mounds on or near the St. John's River more or less thoroughly explored by me, I have taken but one whole skull in good condition. So great is the pressure exerted by heavy masses of sand that often the shafts of tibiæ found at the base of burial mounds have been crushed. Such being the case it can readily be conceived how slender are the chances to recover a skull in perfect condition.

As before no mark of decay was found in any of the teeth though many showed signs of excessive wear. Many of the bones gave evidence of having served in frames endowed with great muscular strength, the ridges being very noticeable.

In the femurs the linea aspera was prominent, some with a tendency towards the "pilaster." But two femurs of the many found possessed the articular portions sufficiently intact to allow measurement as to length.

Of the two of which measurements were taken the length of one was 18 in. (tape) to the tip of the great trochanter and that of the other 16½ in. (tape) to the upper margin of the head. Taking .275 as the ratio of the length of the femur to the entire stature it will be seen that no great height is indicated. Of course no general rule can be drawn from two cases but a large number of femurs exhumed from the Tick Island mound with articular portions more or less decayed were at least in sufficiently good condition to allow a fairly close estimate and of these and of hundreds of others met with in burial mounds and shell heaps in Florida I can say that none indicated a stature of six feet. Four tibiæ exhumed intact measured respectively 14½ in., 12⅜ in., 12 5-6 in., and 14½ in. in length (tape).

Platycnemism.

It will be remembered that in recent years a marked lateral flattening of the tibiæ has been noticed as a characteristic of early and savage races in various parts of the world. This flattening exists in a varying degree and is frequently found in connection with anterior curvature. Measurements are usually made where the nutrient artery enters the bone and the percentage of the lateral diameter as compared with the antero-posterior diameter, ascertained.

According to Topinard (Anthropology p. 299 et seq.) the peculiarity was first commented upon in relation to the family buried at Cro-Magnon. He furthermore states that in two hundred Parisian tibiæ dating from the fourth to the tenth centuries 5.25% were platycnemic while 14% were bent. Unfortunately the degree of flattening is not given.

Prof. Wyman (Fresh Water Shell Mounds of the St. John's River, Florida, page 67) says "the proportion of the transverse to the fore and aft diameter in whites as compared with Indians, comprising mound builders, is as follows: The fore and aft diameter being taken as 1.00 the transverse in twelve whites 0.70, in twelve from the mounds of Florida 0.64, in seven from mounds in Kentucky 0.63, in two from Osceola mound (a shell heap now known as Crow's Bluff) 0.59, three from the mound on the St. Clair River 0.60, five from the mound on River Rouge 0.53, in an Aleutian islander 0.56, in an Eskimo 0.60, in a Californian 0.53, in a tibia from the Merrimac River 0.60, in a Peruvian 0.50, in a Gorilla (male) 0.57, Gorilla, (female) 0.71, Chimpanzee 0.65." It must be borne in mind that Prof. Wyman's researches into the burial mounds of Forida were very superficial (see foot-note Fresh Water Shell Mounds, page 47) and his measurements probably relate to tibiæ of intrusive burials, though between the tibiæ of later Indians and those from original interments in various sand mounds of the St. John's the difference in flattening is not marked.

Another point carefully to be borne in mind is that the measurement of a single tibia amounts to little in the estab-

lishment of a race characteristic. Between the maximum and minimum degree of flattening among the tibiæ found at Tick Island was a difference of 31%.

Prof. Edward S. Morse (Shell Mounds of Omori) gives the percentage of nine recent Japanese tibiæ as 0.74, one tibia from the shell heaps of Omori 0.62, one from a shell heap in the province of Higo 0.5002.

In Michigan platycnemism has been noticed to a marked degree. Mr. Henry Gillman (Smithsonian Report for 1873 page 368) cites nine tibiæ from a number found by him in the great mound on the Rouge River and in the circular mound on the Detroit River. Of these the average was 0.486, the lowest being 0.402.

It is to be regretted that the average of the entire number found is not given.

Of the very many tibiæ exhumed at Tick Island fifty-five were in condition for measurement, many being broken at a point too low for determination, while others were crushed. It is of course apparent that all tibiæ must be discarded where a lateral flattening exists through causes acting on the bone after interment, since measurements made without due care in this respect would give and unfairly, a very low percentage to the lateral diameter.

All measurements are made with calipers in hundredths of an inch. Of the fifty-five tibiæ the least platycnemic measured transversely .96 inch and antero-posteriorly 1.16 inch, a percentage of 82, while the two lowest (now in my possession) were respectively .72x1.41 and .75x1.45 or 51% and 51.7%, the average for the fifty-five tibiæ being 63.9%.

In this connection it is possible that statistics as to tibiæ found by me in other mounds of the St. John's may be useful for purposes of comparison.

	Per cent.
Burial mound at Ginn's Grove near Lake Jessup; three tibiæ, intrusive burials, average	64.77
Thirty-three tibiæ, original burials from base of mound average	64.9

Persimmon mound, about twenty miles south of Lake Harney; burials in shell heap, 4 tibiæ	58.3
Orange mound, near Persimmon mound; original burials in shell, three tibiæ	58.
Raulersons, south-eastern end of Lake Harney; burials (?) nine tibiæ	62.5
Small burial mound, Stark's Grove, Lake Beresford; one tibia	84.
Shell heap, near Econlockhatchee Creek; burials (?) three tibiæ	59.9
Burial mound on Blue Creek, near Volusia; one tibia	64.8
Burial mound, Thornhill Lake, near Lake Jessup; two tibiæ, three feet from surface	60.4
Three tibiæ, original burials	65.
Burial mound opposite Huntoon Island; original burials, five tibiæ	62.
Intrusive burials, five tibiæ	64.
Burial mound, Fort Taylor, Lake Winder; original burials, four tibiæ	64.8
Mulberry mound, near Lake Poinsett; original burials, sixty-six tibiæ	66.2
Bluffton, sand mound; intrusive burials, three tibiæ	70.7

Perforation of the Humerus.

The perforation of the wall between the fossæ at the lower end of the humerus seems to be a characteristic of early and unmixed races. The perforation does not necessarily occur in both humeri of the same person. Mr. Henry Gillman (American Naturalist, 1875, page 427) noticed it in the mounds on the Detroit and Rouge Rivers, Michigan, but unfortunately bases the percentage of its occurrence on an estimate.

Topinard (Anthropology page 298 et seq.) furnishes an interesting table as to the frequency of the occurrence of the perforation of the humerus at various periods in France.

Number of humeri.		Per cent.
66	Caverne de l'Homme Mort (La Lozere)	10.6
368	Dolmens of La Lozere	10.6
128	Stations of Vaureal, Orrouy and Chamans	21.7

(Polished stone period.)

44	Pre-gallic station of Campans	12.5
42	Mountaineers of the Ain (5th Century)	27.7
69	French Basques	13.4
200	Parisians of the 4th to the 10th century . . .	5.5
218	Parisians of the middle ages	4.1
150	Parisians anterior to the 17th century	4.6
1000	(?) Merovingians of Chelles	2.0

It is well to remember in examining the olecranon fossa that the partition, if it exists, is often extremely thin and when sand or earth is removed with a pointed instrument an artificial perforation may result. In the humeri examined by me at Tick Island and other burial mounds, data as to which are furnished for comparison, all foreign substances were removed from the cavity with the aid of a soft brush. It is therefore believed that none but pre-existing perforations are enumerated.

				Per cent.
46	Humeri, Tick Island,	16	Perforated . . .	34.8
42	Humeri, Ginn's Grove,	9	Perforated . . .	27
7	Humeri, Persimmon mound,	4	Perforated . . .	57
4	Humeri, Orange mound,	0	Perforated . . .	
19	Humeri, Raulerson's	8	Perforated . . .	42
2	Humeri, Lake Beresford	0	Perforated . . .	
3	Humeri, Econlockhatchee Creek	1	Perforated . . .	33.33
9	Humeri, Thornhill Lake	6	Perforated . . .	66.66
14	Humeri, opposite Huntoon Island	7	Perforated . . .	50
4	Humeri, Fort Taylor	1	Perforated . . .	25
76	Humeri, Mulberry mound	40	Perforated . . .	52.7
3	Humeri, Bluffton	3	Perforated . . .	100.
229		95		41.5

Pathological Specimens.

In the former excavations a number of tibiæ were found with marked anterior curvature and increase in the circumference of the bone with roughened surface. But one of this nature was met with upon the last visit to Tick Island, at five and a half feet from the surface and twenty-five feet from the margin of the base of the mound.

Perforated Crania.

One cranium with perforation at parietal eminence .7 in. antero-posteriorly and .6 in. transversely was the only skull found showing perforation and in this case the uneven margin showed it to be the result of a blow from a pointed instrument, having nothing in common with the round and even perforations found in fragments of two crania during previous investigations.

Pottery.

Throughout the entire upper stratum were found fragments of pottery, the large majority undecorated but some ornamented with parallel lines.

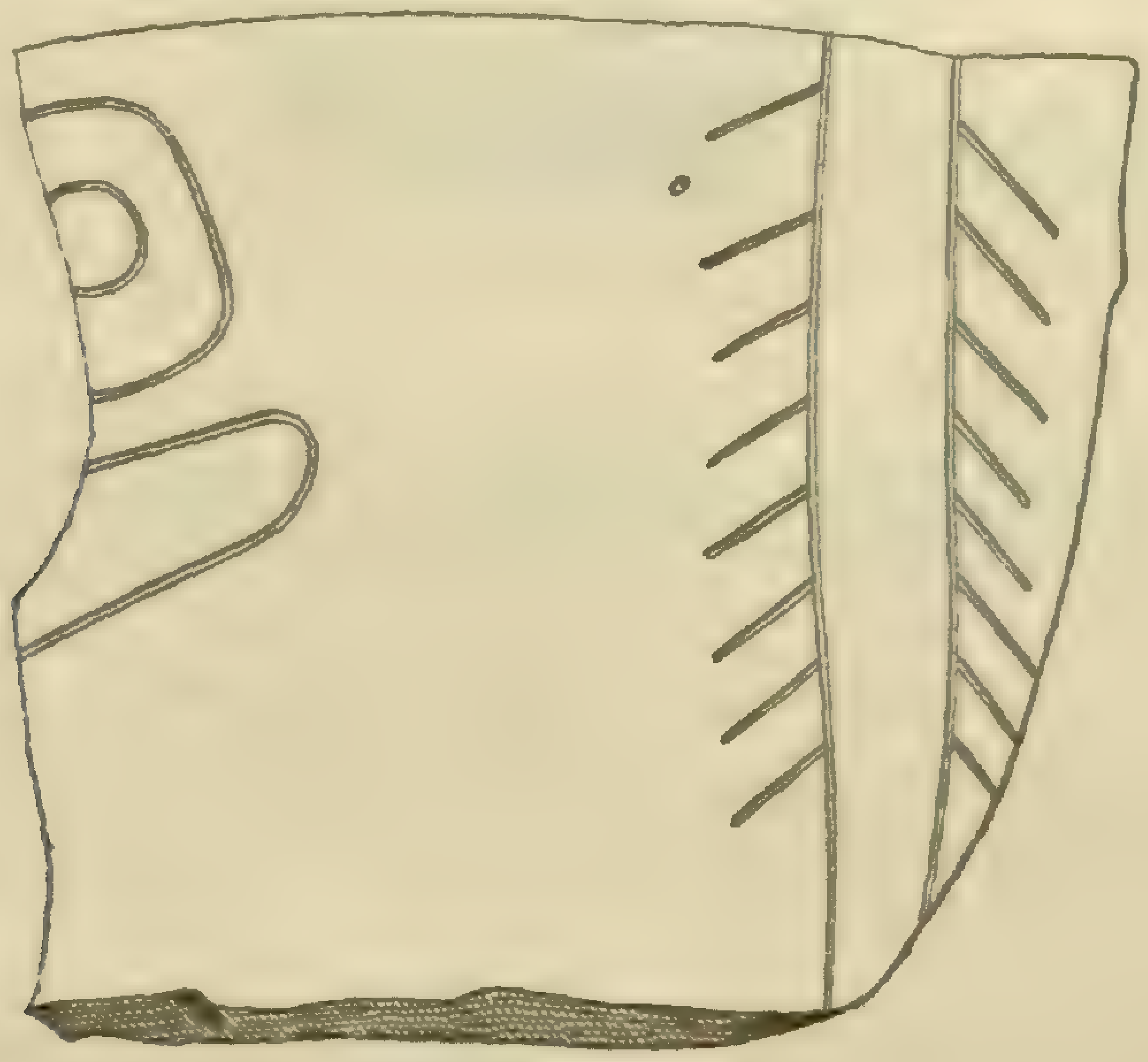


Fig. 1.

In the white sand layer were found bits of pottery in immediate association with every skeleton, many plain, some rudely ornamented in the same manner as those found in the stratum above.

One piece found near the bottom of the white sand layer bore a pattern not met with by me in any other sand mound or in several hundred excavations in shell heaps on or near the St. John's. (Fig. 1.)

At forty-two feet from the circumference of the base and ten feet from the surface of the mound, at the bottom of the white sand layer, with the crumbling bones of a skeleton was found in perfect condition a small earthenware pot with sides deeply grooved, of a pattern entirely unfamiliar to me. (Fig. 2.)

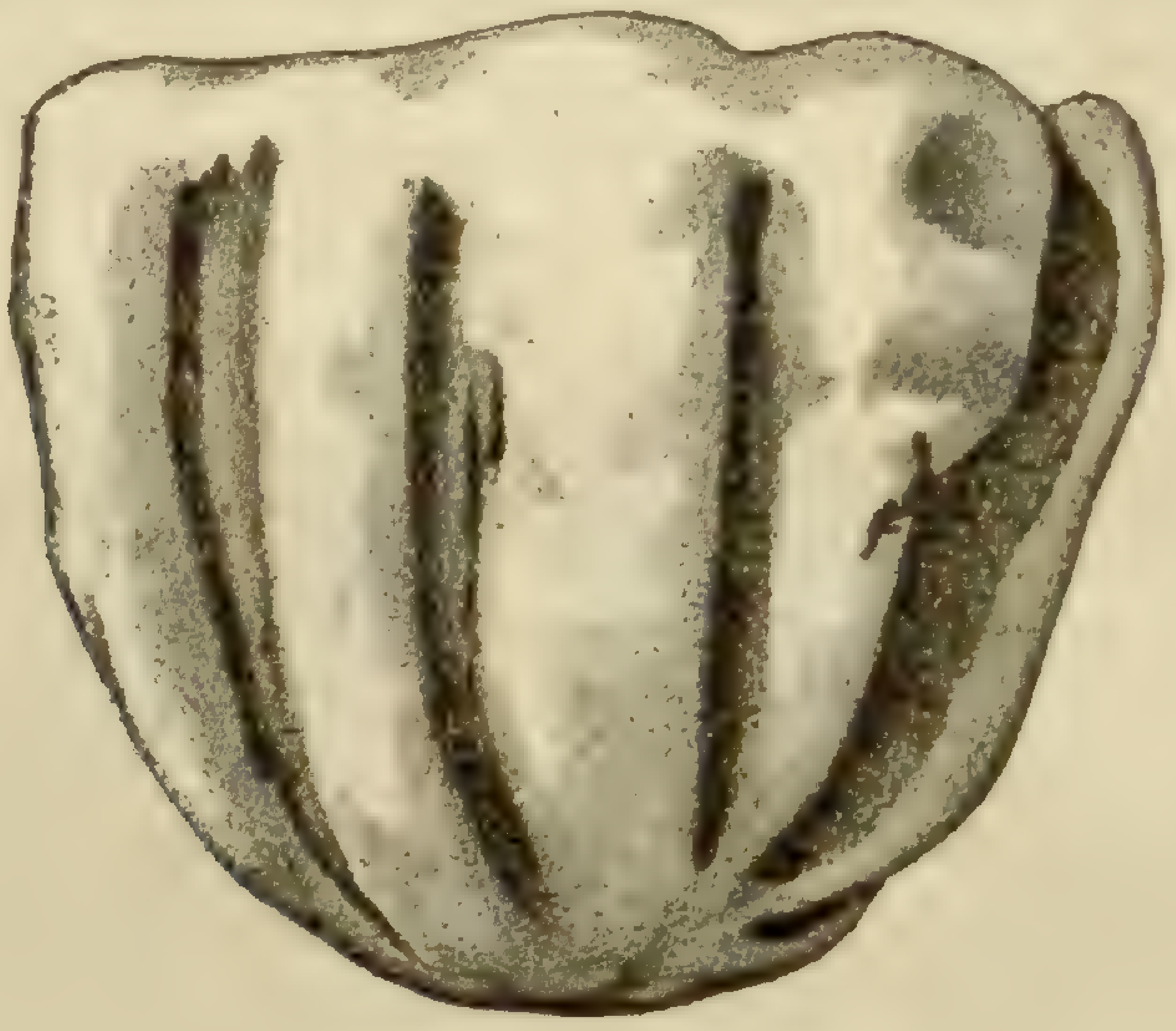


Fig. 2.

Pottery decorated with knobs, of which several specimens were found last year, was not met with during these supplementary investigations at Tick Island nor have I seen them on or below the surface in mound or shell heap on the St. John's River between Palatka and Lake Washington, a distance by water of about three hundred (300) miles. This knobbed pottery was sent to the Peabody Museum of Archæology and a report from the very high authority there could not fail to be of interest.

Fragments of Pottery Shaped in the Form of Spear and Arrow Points.

Reference was made to this subject in my former paper.

During the supplementary investigations many bits of pottery broken in triangular shapes, were found particularly with the burials in the lower sand layers. At least two fragments of pottery were found giving unmistakable evidence of the arrow-head shape having been conferred through design, the sides being chipped rudely to imitate the point of the arrow. Since the writing of my first paper I have secured so much evidence tending to show that the Indians of the earlier burial mounds substituted with their burials the imitation for the real in the way of arrow-heads and spear points that I regard the question as virtually settled.

In the mound at Ginn's Grove, south of Lake Monroe, the custom was very apparent; the great sand mound on Lake Winder emphasized the fact, while in the small burial mound discovered by me near Lake Poinsett nearly every piece of pottery was broken or chipped in the form I have described.

Implements, Ornaments, Etc.

About three feet below the surface, not in association with any skeleton, a very beautiful polished celt 8½ in. in length was brought to light. This implement cannot however be regarded as belonging to the period of the construction of the mound.

Other objects of interest were:—a piece of coquina rudely fashioned in the form of a spear head; two flakes of flint; portion of "conch" shell; two pieces of madrepore; shell implements of doubtful attribution; handful of shell beads with skeleton of child five feet below the apex of the mound. With the beads were a fragment of calcined bone and a flake of flint. Two feet distant was the claw of a large animal, probably a bear. On the shell base not far from the center of the mound were found a number of pieces of what Professor Putnam pronounces to be soft coal and furthermore states that

any previous discovery of this commodity in Florida is unknown to him.

Possible Indications of Cannibalism.

At the bottom of the white sand ridge, nine feet four inches from surface and thirty-five feet from circumference of the base of the mound, was found a skeleton very badly decayed. Immediately below were apparently the remnants of a feast consisting of a fragment of charred bone and four pieces of bone showing no action of fire, of which two were human. These fragments entirely unassociated with any others were in a better state of preservation than the skeleton immediately above owing to the shell below them. In every way they resembled the bones of the shell heaps.

From one fragment, a portion of the lower jaw of a child, every tooth was missing. While no definite conclusion can be arrived at in this connection it may be permissible to suggest that the process of boiling would be conducive to the loosening of the teeth. No other isolated human bones were found in the white sand layer.

An Intrusive Burial.

As before stated intrusive burials were frequent in the Tick Island Mound. A description of one of these may be of interest. It will be rememberd that flexed burials vary greatly in the mounds of the St. John's as to the degree and form of flexion.

Near the apex of the mound, eighteen inches from the surface, lay a skeleton in a fairly good state of preservation, though the skull was crushed beyond recovery. The body lay belly down, the face rotated to the right with the neck flexed in that direction. The left lower extremity had the thigh flexed to the abdomen, the leg flexed on the thigh with the foot extending downward. The right lower extremity had the thigh abducted and rotated externally to the transverse plane of the body and flexed to a right angle, the leg flexed on the thigh and the foot extended. The arms were somewhat

disturbed by digging but enough was seen to show that they were not folded on the abdomen as is often the case. The skeleton was of a man, the length of one femur was 16½ in. One humerus was perforated, of the other the portion necessary for determination was decayed. One tibia was 14½ in. in length. The lateral diameter was .82 in., the fore and aft measurement at the same point 1.44 in. giving a percentage of 57.

Comparative Age of the Mound.

As was the case during previous investigations no object indicating intercourse with the whites was found. Taking into consideration the quantity and quality of the pottery it is probable that the Tick Island Mound is of more recent construction than certain other burial mounds on the St. John's in which no pottery is met with, for judging from its almost universal association with skeletons in so many mounds we must consider it probable that no cause save ignorance of the art of its manufacture can explain its absence in other burial mounds.

In a careful investigation of the shell heaps of the St. John's made by me, extending to Lake Washington, during which several hundred excavations were made in upwards of sixty localities, nothing in anyway indicating the presence of the whites was ever brought to light. It will be remembered that Prof. Wyman's investigations had the same result. There are then strong reasons to believe that the last shell heap was completed prior to the arrival of Europeans.

In a large shell heap of the upper St. John's I was fortunate enough to discover under several feet of shell a stratified burial mound, particulars of which I hope to publish later. From this discovery and from the fact that presence or absence of pottery in the mounds as a rule coincides with neighboring shell deposits I am inclined to believe that the larger burial mounds including Tick Island are contemporary with the later shell heaps at least and were abandoned prior to the coming of the whites.

EXPERIMENTAL EMBRYOLOGY.

By E. A. Andrews.

(*Continued from May number, p. 382.*)

Schultze[1] holds that the black pole becomes the dorsal region on which the medullary folds are formed, and that the blastopore arises and remains near the tail end of the animal, at the highest part of the white yolk, when the egg is, as is normal he says, inclined about 45°. There is, however, a rotation of the egg about a horizontal axis at right angles to the plane of symmetry, a rotation that carries blastopore downward 80°. Yet this is compensated for by a reverse rotation upward of 90°, so that there is little absolute change after the blastopore is closed ; the ingrowth of entoderm during gastrulation being, he surmises, the cause of these revolutions, since the egg is thereby overbalanced, first one way then the other.

After this digression beyond the limits of experimental embryology into the hazy ground of unverified hypotheses we may turn attention to a work rich in experimentation, the only French contribution that we are acquainted with, the very suggestive work upon the ascidian egg by Chabry,[2] whose paper appears not to have met with the appreciation it deserves.

Having made a very careful study of the cleavage phenomena in normal eggs of *Ascidia aspera* in the summer seasons of 1884 and 1886, the author was in a position to appreciate the remarkable abnormalities sometimes occurring in the development of this ascidian. As these abnormalities to some extent correspond with the results of artificial treatment of the eggs, some account of them cannot be passed over here,

[1]O. Schultze, Ueber Axenbestimmung des Froshembryo. Biol. Centb., vii, 1888, pp. 577–588.

[2]Contribution a l'embryologie normale et tératologique des ascidies simples. Jour. de l'Anatomie, 1887, pp. 167–813, plates 18–22.

especially as they furnish in themselves interesting facts bearing upon our interpretation of embryological phenomena.

Without apparent cause, unless, as the author inclines to believe, old age of the adults is here concerned, all the ascidians obtained late in one season gave rise to abnormal eggs, few amid the entire number developing in the normal way for any length of time. These natural monsters or deficient eggs can be explained only on the assumption that the parent organism made them imperfect from the start, or at least furnished abnormal conditions of environment for them before they were laid, as they may develop in the same aquaria with other eggs that follow a typical series of changes without any abnormalities. Moreover the eggs from one adult often show some common defect or tendency to be abnormal in certain lines, though there is great individual difference between even these eggs.

These abnormalities of unknown or natural origin are classified under the following seven heads: 1st, change from the normal position of the cleavage planes; 2d, retarded cleavage; 3d, cleavage confined to the nuclei; 4th, absence of cleavage; 5th, fusion of cells; 6th, unusual migrations of cells; 7th, death of cells. The presence of one or more of the above factors and their various combinations gives rise to the numerous monstrosities found during the cleavage, gastrulation and larval life; moreover one abnormality gives origin to others later on in development, so that larvæ with great defects are classed as cases of death, for instance, of one or more cells in an early stage.

In addition to the various abnormalties thus classified some other forms, such as a larva with well-developed double or bifid tail, were observed but not traced back to any of the above seven categories.

The interest of these various modes of irregularity lies, for our present purposes, in the fact that all seven conditions have been artificially brought about by M. Chabry by various mechanical stimuli applied either to the egg of the ascidian or to that of the sea urchin. The results upon the ascidian were for the most part obtained by means of traumatic inter-

ference, and lead only to the death of cells. These abnormalities are the ones described in the sequel, while other classes of abnormalities are either obtained by other methods applied to the egg of the same animal or else refer to the egg of the sea urchin, *Strongylocentrotus lividus*, and are not mentioned in detail in the present paper.

Wounding the cells of *Ascidia aspera* in early stages leads to the death of these cells and to subsequent abnormalities of development identical with those resulting when the cells die naturally or without apparent cause.

The method of inflicting injuries upon one or more cells of the minute eggs studied by M. Chabry is as simple in principle as it is successful in operation, given sufficient delicacy in manipulation. The eggs are observed under the microscope in capillary tubes of glass, each egg lying without undue pressure in a separate tube of right diameter. The tube is mounted in water and covered by a cover glass so that a clear view of the egg is obtained with quite high powers. To see all sides of the egg the tube is revolved by a small crank and wheel attached to one end, turning freely in two rings of glass fixed to the microscopic slide.

The other end of the tube bears the exceedingly sharp pointed needle that is to perforate the egg. This needle is the most difficult part of the apparatus to manufacture, being a glass rod drawn out to a point of excessive acuteness and also straight. When once made the needles are provided with a protecting piece of capillary tubule, which may either pass into the capillary containing the egg or else be joined to its end by a surrounding tube according as the egg capillary is large or very small. To move the glass dart in and out, towards and away from the egg when it has been first rightly adjusted, a small lever attached to the microscope by an ingenious and simple arrangement of spring and screw enables one to thrust the point, while observing it under the microscope, into the egg for a given distance and not further, and then to withdraw it quickly. Thus stabs are made that need affect but a single cell and any known and chosen cell.

Such is the accuracy and delicacy of this apparatus that the sea urchin's egg, only one tenth of a millimeter in diameter, was actually pierced by the finer glass needles.

To begin with this latter experiment upon the sea urchin, the needle is followed by sea water, which remains in part within the egg when the needle is withdrawn but yet gradually disappears as the egg closes in over the wound and does not afterwards exercise any evil influence upon the subsequent development of the egg. An egg entirely pierced from one side to the other subsequently formed a normal pluteus.

In the ascidian, however, the perforation of the egg or of one of its cells gives rise to its death. Within a minute after the stab is made in the protoplasm of the cell an appearance of opacity or turbidity is seen rapidly extending through the entire cell; the cell dies. Later the protoplasm coagulates and remains fixed in whatever form it was fashioned by the pressure of adjacent cells when it died. This death of the cell by stabbing is a different, much more rapid, process from the gradual death observed to occur in many eggs of abnormal origin. The part of the egg not injured develops, however, just as when the death of its fellow cell was natural or of unknown origin. In this development certain definite rearrangements of the cells take place, since they are no longer held in normal positions by the attraction of the dead cell; then cleavage continues and finally imperfect larvæ result.

Some examples of the results obtained may be given here in detail. In normal cleavage the egg divides first into a right and a left cell, these divide into anterior and posterior cells, and the four resulting cells then divide equatorially into oral and aboral cells. If, in the two-celled stage the left one be killed, the right divides into an anterior and a posterior cell as if nothing had happened to the egg, and then these two divide as usual but arrange themselves much as if the dead cell were not present, pressing together into a spheroidal mass so that the posterior upper and anterior lower cells come into contact diagonally on one side next the dead cell or median plane, just as do the other two cells on the outside or right of the egg. Thus under the influence of

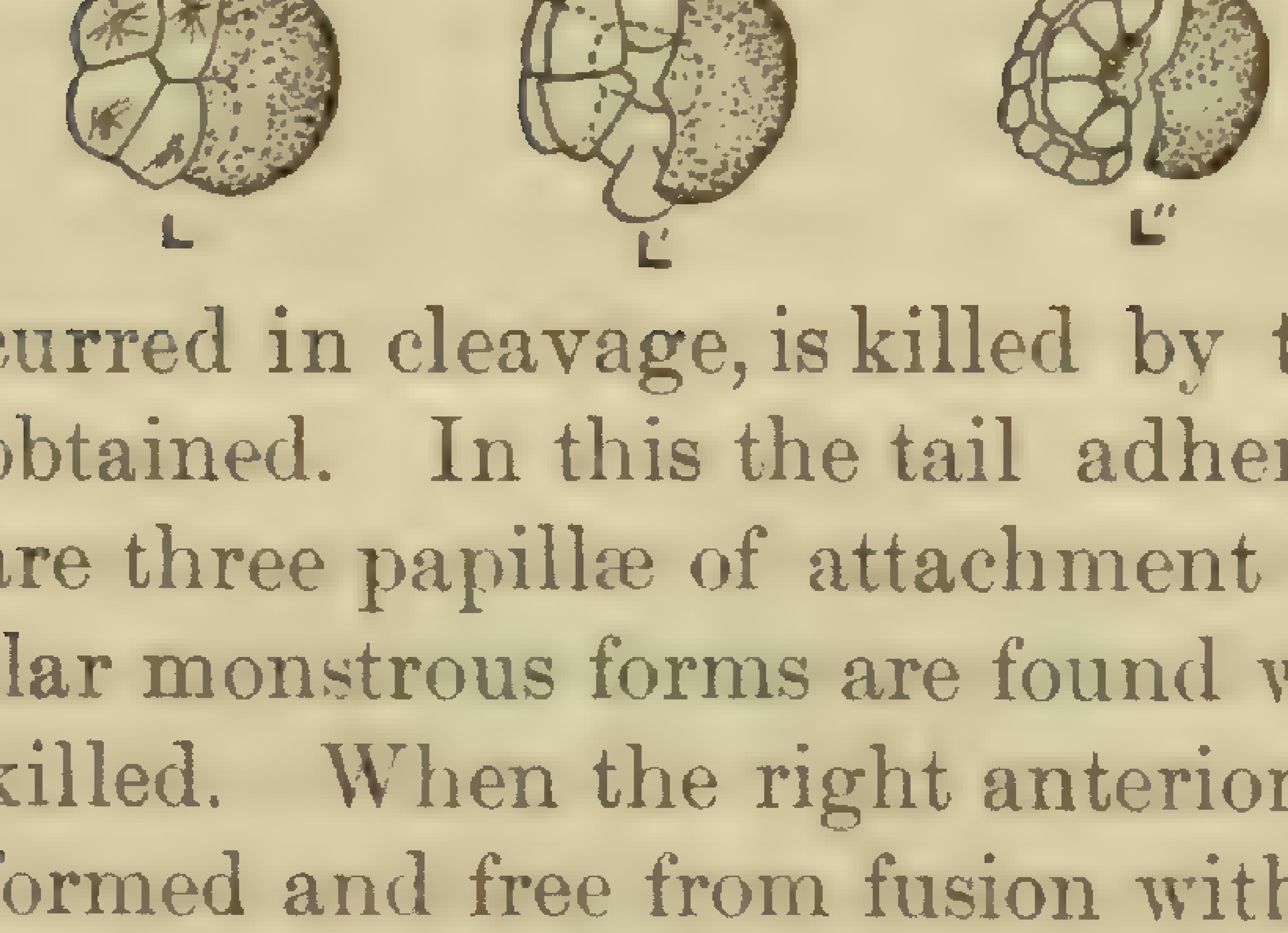
mutual attraction the four cells move so that they are arranged in a tetrahedron rather than in a square. The next change is a division of each by a plane parallel to the median plane or to the face of the dead cell.

This illustrates a marked tendency in all natural cases of death; that is, the planes that normally would be nearly meridional, turn so as to become parallel to the dead cell, parallel to a plane passing through the center of the egg.

From this eight-celled stage the development proceeds till a larva is formed, having a normal tail, three distinct germ layers, a pigmental area representing the nervous system and one papilla for attachment. Having begun to secrete its cellulose mantle it died.

Other cases were obtained showing the same results. Figure 2, R, R′, R″ shows three successive stages in the development of one of these artificial right-half embryos compared with successive stages, L, L′, L″, in the development of a left-half embryo of natural or unknown origin.

FIGURE 2



Again, when the posterior left of the normal four cells, after two planes have occurred in cleavage, is killed by the needle, an ovoid larva is obtained. In this the tail adheres along the trunk and there are three papillæ of attachment and two pigment spots. Similar monstrous forms are found when the right posterior cell is killed. When the right anterior cell is killed the tail is well formed and free from fusion with the trunk, and there are no pigment spots or imperfect ones. When the left anterior cell is killed the larva has a perfect tail, a papilla for fixation, a pigment spot and active movement. It escaped from most of the egg membranes and secreted a tunic, into which migratory cells were passing when it died.

Killing two diagonal cells of four is followed by a normal cleavage of the two remaining cells, but the experiment was

interrupted here. Killing both left cells of the four, results in the formation of larvæ which are imperfect in that there is but one papilla for attachment and one atrial invagination with one pigment spot or eye. Similar monsters result from killing both right cells, but the eye spot is absent.

When three of the four cells are killed the remaining one divides normally and forms a rounded mass of cells arranged in two germ layers, but the development does not continue further. Likewise by thrusting the needle amongst the cells of a cleaving egg, though some are killed a few may be separated and then live isolated in the sea water. Such a cell divides, with karyokinesis, into two, four, eight cells by planes at right angles, then the normal rearrangement and adjustment of the cells take place as if an entire egg were in question. The cleavage planes also occur at intervals of 20 minutes as in the entire normal egg. There results after some hours a rounded mass of twenty or so cells, larger than the original one, but there the development ceases.

In such experiments M. Chabry sees a new method of anatomical research; the history of each cell may be followed from early to late stages by killing it and observing the consequent lack in the resulting imperfect later stages. Though it is unsafe to conclude from the disappearance of an organ after the death of some particular cell at an earlier stage that that cell would have formed the organ, yet by killing all the other cells, one by one, and finding the organ present in all the resulting stages, its dependence in the normal condition upon the cell first killed becomes conclusive. In this way the author traces the eye to the right anterior cell of the first four of cleavage, the otolith to the right posterior cell; the two papillæ for attachment come from the two anterior cells while the chorda is formed by both anterior and posterior cells. Nevertheless as left-half larvæ are sometimes found with an eye, and other such cases occur, the above is upheld by the author only by aid of the supposition that the surviving cells change their habit after the death of the one, so that they now produce organs they would not normally. Thus the eyes are potentially two, though but the right one is normally produced.

Similarly the notochord is to be regarded as double or composed of two halves, one in each of the first two cells.

Nevertheless, M. Chabry regards the egg of *Ascidia aspera* as containing potentially but one adult, the organs of which seem to be localized in different parts of the egg. That this is necessarily true of other eggs he emphatically denies; the results here obtained cannot, he thinks, be extended to other untried cases. Granting that there is this localization of some organs in the ascidian egg it is evident from the author's account that all the structures are not divided by the first cleavage but rather that each cell has for the main part all that the other has, hence result active larvæ from either right or left cell, if the other be killed, larvæ which are deficient in only a few organs and by no means real half-larvæ as the author calls them.

Finally we may consider some of the experimental work that has been recently attempted upon eggs of lower animals, the echinoderms especially.

Oscar and Richard Hertwig[1] subjected eggs of *Strongylocentrotus lividus* to the action of heat, poisons and mechanical insult, to judge from the effects upon external and internal fertilization and upon cleavage as to the nature of the forces involved in the normal course of events. All these unusual agents act upon the egg so that it is unable to keep out more than one sperm, and hence is penetrated by several or many sperm, exhibiting the abnormal phenomena of polyspermy.

Weak reagents cause only a few eggs to take in two or three sperms, while strong reagents cause most all the eggs to take in four or more sperms. The substances used and the strength as well as time are given in the following tables:

WEAK REAGENTS.

Nicotine	1 drop to 1000	for 10 minutes
Strychnine	.005%	for 20 minutes
Morphine	.1 to 2%	for 2 hours

[1] O. and R. Hertwig. Ueber den Befruchtungs- und Theilungs- vorgang des theirischen Eies unter dem Einfluss ausserer Agentien. Jen. Zeit. xx, 1887, pp. 120–227, 477–510, plates 3–9.

Cocaine	.025%	for	5 minutes
Quinine	.005%	for	5 minutes
Chloral	.2%	for	12 minutes
Heat	31°C.	for	10 minutes

STRONG REAGENTS.

Nicotine	.1%	for	20 minutes
Strychnine	.01%	for	20 minutes
Morphine	.4%	for	5 hours
Cocaine	.1%	for	5 minutes
Quinine	.005%	for	1 hour
Chloral	.2%	for	3 hours
Heat	31°C.	for	45 minutes

These do not all act alike; quinine, chloral and probably cocaine and overheating temporarily stops the movement of the sperm, a diminution in size of the fertilization elevations upon the egg, postpone cleavage one-half to one and one-half hours, interrupt cleavage of nucleus, sometimes making it take retrograde steps, and interfere with formation of rays within the protoplasm of the egg.

Nicotine and strychnine, on the other hand, seem to increase the activity of the sperm and the contractility of the egg protoplasm. Morphine appears to have an intermediate action.

The authors explain the occurrence of polyspermy after the action of these agents as being due to the lack of normal sensitiveness on the part of the ovum. For normally the entrance of one sperm causes the egg to throw off a membrane which prevents the entrance of others, a membrane which is seen to be formed even upon fragments of eggs shaken loose before cleavage, yet when acted upon by these drugs the protoplasm of the egg is not sufficiently stimulated to form a membrane until several sperms have entered.

The internal fertilization, fusion of male and female nuclei, may be also retarded as much as one hour, and various unusual phenomena introduced in connection with the supernumerary sperms, without necessarily preventing the ultimate development of the oosperm.

Omitting many interesting facts bearing upon the value of male and female nucleus and cell protoplasm we pass to the effects upon the cleavage processes. The results are similar, whether the drugs act to produce polyspermy or whether they are subsequently applied after normal fertilization. Quinine or chloral acting upon an egg having its cleavage nucleus in the spindle stage transforms this spindle into a cluster of vesicles, but if the egg is now allowed to recover in sea water the nucleus divides into four with the formation of four combined spindles. The protoplasm, however, remains affected, and does not follow the subsequent division of each of the four nuclei.

The above work was supplemented soon after by a paper by Oscar Hertwig[1] describing the effects of cold upon the fertilization of the eggs of the sea urchin, and also recording the occurrence of abnormal eggs in most of the specimens found at Triest in the Spring of 1887; this result being apparently due to the unusual cold which prevented the animals collecting as usual when ripe (he finds the females discharge ova in the aquarium when a male has discharged sperm), and hence led to an overripe condition of the eggs, accompanied by subsequent abnormalities in development.

Eggs, he finds, may be kept for several hours at a temperature of 2° to 3°C. and yet recover, but they finally enter into a cold rigor. The cooling prevents the egg from forming its protective membrane and diminishes the receptive elevations upon the egg, and thus polyspermy results if the rigor does not intervene before the sperms have entered. Cooling after external fertilization may arrest the progress of the sperm, which is yet able to advance again when warmed. Cooling during the cleavage affects the nucleus so that various abnormal changes result, but the egg may still divide regularly when warmed, at least in a few cases.

One other suggestive experiment was made, namely, the treatment of sea urchins' eggs with methyl blue. This acts like a poison in causing polyspermy, yet weak solutions may be

[1]Oscar Hertwig. Experimentelle Studien am Tierischen Ei während, und nach der Befruchtung. Jen. Zeit., xxiv, 1890, pp. 268–310, plates 8–10.

used to stain the egg a violet color and yet not prevent it developing into a blastula in which the central fluid, the migratory cells and the inner ends of the outer cells are violet.

The method of inflicting mechanical injury upon sea urchin eggs used by the Hertwig's resulted in breaking them in some cases; this means of separation has been ingeniously put in action by Boveri in the attempt to solve a most important problem. Though the perusal of this paper[1] does not inspire one with as much confidence in the strength of the conclusions drawn as the reader would wish to have in evidence advanced in so important a case, yet the experiments are in themselves very suggestive and worthy of frequent repetition.

To prove that the nucleus is the bearer of inherited characters we may try to combine a nucleus with a cell and see which or if both transmit their peculiarities.

Using Hertwig's method he shook eggs of the sea urchin in test tube till many lost the nucleus; these could be fertilized and developed. In this way dwarf larvæ, about one-fourth the normal size, were reared as late as the seventh day, when the normal larvæ died also. Now the great interest of these experiments for the present question lies in the fact that the eggs belong to one species and the sperm to another.

When true bastards between normal eggs of *Echinus microtuberculatus* and sperm of *Sphærechinus granularis* are formed the resulting larva has always a middle form between the larvæ of these species, both in general proportions and in arrangement of skeletal spicules. When, however, broken fragments of the eggs of the first species are fertilized by sperm of the second we find beside some true bastards from the normal eggs and some small ones from nucleated fragments, some larvæ exactly like those reared from pure eggs and sperm of the second species alone, *Echinus microtuberculatus.*

These larvæ are regarded by Boveri as due to the fertilization of denucleated eggs of the other species by the sperm of the species they resemble.

[1]Boveri. Ein geschlechtlich erzeugter Organismus ohne mutterliche Eigenschaften. Sitzb. d. Gesellschaft f. Morphologie u. Physiologie in Munich, v, 1889, pp. 73–80.

The larvæ, when killed and examined, are found to have abnormally small nuclei, which is accounted for by the supposition that the single male nucleus of the sperm does not furnish as much material as the male and female nuclei normally do when combined.

If we accept these statements we have, indeed, most conclusive proof that in a male nucleus the sperm may transfer to a new organism the qualities of its parent.

The difficulties of the experiment lie in the unfavorable nature of the hybridization, only one in a thousand eggs being fertilized, so that of 200 actually isolated none happened to develop; then again the various abnormalities, half embryos and dwarfs that we may assume occur, make it a difficult question, we think, to decide as to the specific characters of the larvæ being due to inheritance or accidental resemblance from imperfect development.

The recent work of Driesch[1] is the last contribution in experimental embryology that has come to our notice. To determine the effect of light upon cleaving eggs he exposed the eggs of *Echinus microtuberculatus*, *Planorbis carinatus* and *Rana esculenta* to daylight and to complete darkness as well as to variously colored light. The result was that not only cleavage but also the formation of organs took place quite normally in time and form, entirely irrespective of the presence or character of light.

The more noticeable and unexpected part of the paper, however, deals with the question of self differentiation, as illustrated by experiments upon sea urchin eggs (as yet he has not succeeded in applying appropriate methods to eggs of frogs and Planorbis).

The eggs of the sea urchin in the two celled stage are shaken vigorously for five minutes in a test tube (some may need repeated shaking), and then such isolated cells as are present are quickly picked out and examined under the microscope in separate dishes of sea water.

[1]Hans Driesch. Entwicklungsmechanische Studien. I. Der Werth der beiden ersten Furchungs-zellen in der Echinodermenentwicklung. II. Über die Beziehung des Lichtes zur ersten Etage der theirischen Formenbildung. Zeit. f. wiss. Zool., liii, 1891, pp. 160–183, plate 7.

In this way as many as fifty cells were isolated from the two celled stages and kept separate in small vessels in which they could be examined microscopically and actually seen to develop. The separated cells develop at first, as do the uninjured cells of the frog in Roux's experiments, but the ultimate result is that each cell (of the two after the first cleavage of egg) may give rise to a complete though small larva.

This is found to be the case in both Echinus and Sphærechinus.

In the normal cleavage of Echinus, according to Selenka, there are formed two, four, eight cells, and then four at one pole bud off four small cells, while the four at the other pole divide equally. Now in the cleavage of the half egg Driesch finds two and then four cells, followed by an eight celled stage which is formed by or budded from two little cells at one pole, as opposed to an equal division of the two cells at the other pole; thus the eight celled stage is exactly the half, in form and arrangement, of the normal sixteen celled stage.

These half formations, however, become over night converted into complete blastulas having half the normal size, but apparently made up of cells of normal dimensions, so that we may infer there is half the normal number of cells. About thirty dwarf blastulas were obtained from isolated cells, and from these normally formed gastrulas, and eventually, in three cases normally formed dwarf plutei were reared. Thus it would be possible to obtain two plutei from one egg by separating the first two cells of cleavage.

The application of this to the explanation of the occurrence of twins is made easier by the actual finding of numerous abnormal stages in cleavage and gastrulation resulting in the production of twin gastrulæ or larvæ, or in some cases of combination of three-fourths and one-fourth blastulæ. As these occur so frequently in material submitted to the shaking process, which variously effect different eggs, we have reason to suppose the twins are directly due to the mechanical separation or disturbance of the material in the egg.

The heterogeneous character of the various experiments referred to in the present article and the conflicting and often

apparently meaningless results obtained by one or the other of the experimenters, while preventing an immediate incorporation of the facts of experimental physiology with those recorded by the purely observational school should not blind us to the importance of the work thus far done, both as a good beginning in a promising field and as already furnishing valuable controls for the guidance of speculations upon some of the most fundamental questions in biology.

"Toutes les expériences, toutes les mutilations qui èn fait subir à un oeuf normal, contribuent, en effet, à devoiler sa structure, et c'est certainement là une des plus belles recherches que le naturaliste puisse se proposer."

MENTAL EVOLUTION IN MAN AND THE LOWER ANIMALS.

By Alice Bodington.

(*Continued from page* 494.)

Among the lower animals the eager jumping of a dog when he is anxious to go for a walk, his growling, howling and barking to express various emotions are on a similar psychological level with the first demonstration of wishes on the part of the infant. Some of the signs and sounds expressed by domestic animals are indeterminate and some determinate, and every owner of a dog or cat can supply examples for himself.

The next step in advance taken by the infant is the utterance of articulate sounds; first various vowels and labials, *vaguely uttered without definite meaning;* then similar sounds with a definite meaning, as mamma, dada, tata, etc. These early sounds have a very extended meaning, as in Chinese the same word "bye-bye" means bed and bed-clothes, sleep and to go to sleep. But as the application of these simple syllables is usually taught to the child we are not quite at the standpoint of primitive man, who had no one to teach him. There are three different sets of opinions as to the origin of spoken words which have been named the "Pooh-pooh," the "Bow-wow" and the "Yo-heave-o" theories respectively. The first assigns the origin of language to interjectional sounds, the second attributes it to imitation of cries of animals and sounds in nature, and the third considers speech arose from the various noises made by men during concerted action. A fourth assumes language to be a heaven-sent gift and that primitive language began with abstract ideas. Applying the inductive method of reasoning and watching the development of speech in infants and the condition of language in low savages we can hope to form some idea as to how much or how

little truth there is in the above theories. We shall probably come to the conclusion that the first two theories account for a considerable number of words and that "Bow-wow" or imitative language may have given rise to many words whose imitative origin is now obscured. But watching as before the progress of the child we find that *it possesses a faculty hardly, if at all, used by its elders, of coining new words* to suit its own convenience. These words will in many cases be utterly different from the words which the child hears grown-up people apply to an object, yet the new word, having been coined by the child, will be rigidly applied to the particular object or action it was first applied to. Mr. Romanes gives several instances of children who possessed this faculty to a remarkable degree, up to the point indeed, of speaking a language of their own invention. One case is that of twin boys living in a suburb of Boston, "who, at the usual age began to talk, but strange to say, not their mother tongue. It was in vain that a little sister five years older than they tried to make them speak in ordinary English.[1] They had a language of their own, and no pains could induce them to speak anything else. Not even the usual first words 'papa,' 'mamma,' did they ever speak. In fact, though they had the usual affections, were rejoiced to see their father at his returning home each night, playing with him, etc., they would seem to have been otherwise completely taken up with each other. They passed the day playing and talking together in their own speech with all the liveliness and volubility common to children. They had regular words, a few of which the family learned to distinguish, as that for example for carriage, which was 'ni-si-boo-a,' of which the syllables were sometimes so repeated as to make a much longer word." The next case is quoted from Dr. E. Hun, who recorded it in the monthly Journal of Psychological Medicine. "The subject of this observation is a girl aged four and a half, sprightly, intelligent and in good health. It was observed she was backward in speaking, and at two years old only used the words 'papa,' 'mamma.'

[1]Paper read by Mr. Horatio Hale, published in the Proceedings of the American Association for the Advancement of Science, Vol. xxxv, 1886.

After that she began to use words of her own invention, and never employed the words used by others. Gradually she enlarged her vocabulary. She has a brother eighteen months younger than herself who has learned her language, so that they can talk freely together. He, however, seems to have adopted it only because he has more intercourse with her than with the others; he will use a proper word with his mother, and his sister's with her."

The mother has learned French, but never uses that language in conversation and the servants speak English without any peculiarities. "Some of the words and phrases have a resemblance to French, but it is certain that no person using that language has frequented the house. Of words formed by imitation of sounds the language shows hardly a trace. The mewing of the cat evidently suggested the word "mea," which signified both cat and furs. In some of the words the liking which children and some races of men have for the repetition of sounds is apparent. Thus we have 'migno-migno,' signifying water, wash, bath; 'go-go,' delicacies, as sweets or dessert; and 'waia-waia,' black, darkness, or a negro." "Gummigur," we are told, signifies all the substantials of the table, such as bread, meat, vegetables, etc., and the same word designates the cook. A number of additional instances of this strange vocabulary are given.[1] "They show," says Mr. Romanes, "that the spontaneous and arbitrary word-making which is more or less observable in all children beginning to speak may, under favorable circumstances, proceed to an astonishing degree of fulness and efficiency; that although the words thus invented are sometimes of onomatopoetic origin, as a general rule they are not so; that the words are far from being always monosyllabic;[2] that they admit of becoming sufficiently numerous and varied to constitute a not inefficient language; and that the syntax of this language presents obvious points of resemblance to the gesture language of mankind." This faculty of coining fresh words, now almost lost by adults, must once have existed as a normal state of things

[1]Mental Evolution of Man, p. 140.

[2]Where a child uses a monosyllabic word it constantly doubles the syllable.—A. B.

among human beings or it would not survive in the child.

Next to the impression made upon cells by their environment, producing the most profound and extraordinary changes of structure and functions, nothing can be more strange than the persistent heredity or atavism in cells. We can find a parallel for these two opposing forces in the centrifugal and centripetal forces which keep the planets in their orbits. What millions of ages must have elapsed since the ancestors of man diverged from the primeval worm-like hermaphrodite form! Yet not only do numerous organs survive in a more or less rudimentary condition, pointing conclusively to this origin, but there is every now and then a strange relapse to the hermaphrodite condition. The branchial arches found in every mammal with loops of blood-vessels running up to them point to an ancestry less remote, yet for all that, almost unimaginably far away in the past. The pineal gland deep hidden under the immensely developed brain of man, still tells of a third eye which could once look through an opening in the skull. And a small bone of the wrist, of no imaginable use to any mammal at present, may be a survival of an amphibian ancestor's sixth finger. So we may well believe that the faculty of fresh word-making which is being killed out in our children by the use of language ready-made in all around them is capable of a sudden revival. No doubt many of my readers will recall from their own experience the power of coining fresh words possessed by their children and the curious reduplication of syllables employed by them. We may conclude that if miocene man did not coin fresh words for himself and insist upon employing them as he chose, he was incapable of doing what his young descendant can do every day.

With regard to the theory that abstract terms were the first words used we have not only the objection that all abstract terms used by us can be traced back to material objects and actions; and the objection that no one could have understood ready-made abstract terms without a miracle; but the still stronger argument that numberless savage and semi-savage peoples cannot understand and do not use abstract terms to this day. Even so simple an abstract idea as "tail" or "tree" is beyond

the scope of their minds. Numerous instances of this fact are given by Mr. Tylor in his Primitive Culture, but I will cite some of those given by Mr. Romanes. "The Society Islanders have names for dog's tail, bird's tail, sheep's tail, etc., but no word for tail itself, *i. e.*, tail in general. The Mohicans have words to signify different kinds of cutting but no verb 'to cut;' and forms for 'I love him,' 'I love you, etc.,' but no verb 'to love;' while the Choctaw's have names for different species of oak, but no name for the genus 'oak.' Again the Australians have no name for tree or even for bird, fish, etc., and the Esquimau, although he has verbs which signify to fish seal, to fish whale, etc., has not any verb 'to fish.' 'Les langues' De Ponceau remarks 'généralisent rarement,' and he shows they have not even any verb to imply 'I will' or 'I wish,' although they have separate verbal forms for 'I wish to eat meat,' 'I wish to eat soup;' neither have they any noun substantive which signifies 'a blow,' although they have a variety which severally mean blows with as many different kinds of instruments." Similarly Mr. Crawford tells us "the Malay is very deficient in abstract words; and the usual train of ideas of the people who speak it does not lead them to make a frequent use even of those they possess. With this poverty of the abstract is united a redundancy of the concrete," and he gives many instances of the same kind as those cited from other languages. So likewise we are told 'the dialect of the Yubes is rich in nouns denoting different objects of the same genus, according to some variety of color or deficiency of members or some other peculiarity, such as 'white cow,' 'brown cow,' 'red cow;' and the Sechuano has no fewer than ten words all meaning 'horned cattle.' Cherokee presents thirteen different verbs to signify different kinds of washing without any to indicate washing itself. The Tasmanians had no words representing abstract ideas; for each variety of gum tree, wattle tree, etc., they had a name, but none for tree; neither could they express abstract qualities, such as hard, warm, soft, cold, long, short, round. A Kurd of the Yuga tribe who gave Dr. Latham a list of native words was not able

to conceive of a hand or father except so far as they were related to himself or to someone else."

In Prof. Duncan's learned Analysis of the Cherokee Language he confirms the view that savage tribes cannot express such simple abstract terms as 'hand' or 'write.' He says "Human language is not always or necessarily *expressive;* it is sometimes merely *suggestive.* In the lower grades of social life the words are generally few in number and limited in meaning. Many of them can, indeed, hardly be called words; they are more like unintelligible exclamations whose office it is not to imprint an idea or a thought upon the apprehension of the person addressed as do the words of a cultured tongue, but rather to arrest the attention and direct it to the subject in hand, leaving the desired impressions to arise in his mind as the result of his observation and reflexion. In these rudimentary tongues sentences are to be found in an embryonic state. The Cherokee is not aware that his language contains any word for hand; it is always 'äquayānē' (my hand); that is the idea of hand is always attended in expression with a conception of the person to whom it belongs. Now if we should resolve this word and assign to each idea its respective part it would stand thus: 'Äquä ayānē' (my hand), yet if these words should pass under the eyes of a Cherokee he would doubtless fail to recognize them and be apt to repudiate them as something foreign to his native vocabulary.

"While what we have said here is largely true in reference to the nouns it is much more so as to the verbs. The Cherokee never expresses the idea of an action except in connection with that of the actor, and often of the person acted on. And the adjective in expressing a quality seldom loses sight of the object to which it belongs." Speaking of the Cherokee word signifying write Prof. Duncan says: "It is to be doubted whether it was ever heard or written except in some such conglomeration of vocables as 'Wētsóyawĕlēnētóyĕ,' of which the portion 'awāl' conveys the idea of writing or drawing.[1]" In its abstract state the word would, however, be quite unintelligible and requires combination with various pronouns, tense

[1]American Naturalist, p. 775, September, 1889.

and mode signs before it can be understood or used by a Cherokee.

It is not contended, of course, that a savage *has* no general or abstract ideas because he *may* be incapable of expressing them. Animals have general ideas which they cannot express in language. And the savage who has no name for trees would be extremely surprised if he saw one standing on its tips with its roots in the air; one may be sure he has a general idea of a tree, with its roots in the ground and its tip towards the sky. In the same way the horses and camels at Batoura which were inordinately terrified at the first sight of a carriage and pair knew they saw something quite fresh and unaccustomed, though they had no word for it. And the horses and cattle which have grown accustomed to trains have a general idea that the rushing, screaming, roaring object is perfectly harmless, though they cannot say so. Moreover they acquire this conviction from experience.

If, then, we can accept ontogeny as a guide in understanding the primitive beginnings of human speech we may conclude that the steps consisted of screaming, varied in tone as fear or anger was to be expressed; vague labials formed by the passing of the air through the lips and gums; then labials uttered with a distinct purpose, followed in many cases by *new words invented by the child for objects.* My efforts to induce a child of my own to say "milk" resulted in the invention of the word "ningey" for that article of diet, and the attempt to teach two other children to say "nurse" resulted in the christening of that functionary as "wo" and "nan," respectively; in fact, the invention of a completely new word is as easy for a child as it is notoriously difficult for an adult human being.

One of the most extraordinary boundaries that could have been selected as the "Rubicon of mind" has been fixed in the possession of a verb which once expressing such simple concrete ideas as "to stand," "to breathe," has acquired the abstract signification "to be." "If a brute could think 'is' brute and man would be brothers." Here is the point where instinct ends and reason begins. It is not possible to produce

a brute which can *say* "is" (whatever it may think), for the simple reason that brutes do not employ articulate language. But languages belonging to the highest ancient civilizations, as "well as the languages of savages, have also no word for "is." Taking one instance only, the Coptic, it has been observed[1] "what are called the auxiliary and substantive verbs in Coptic are still more remote from all essential verbal character than the so-called verbal roots. On examination they will almost always be found to be articles, pronouns, particles or abstract nouns, and to derive their verbal functions entirely from their accessories or from what they imply. In fact, any one who examines a good Coptic grammar or dictionary will find there is nothing formally corresponding with our 'am,' 'art,' 'is,' 'was.' The Egyptians had, however, at least half a dozen methods of rendering the Greek verb substantive when they desired to do so." Instead of saying 'Petrus est,' 'Maria est,' 'Homines sunt,' it is quite sufficient and perfectly intelligible to say 'Petrus hic,' 'Maria hoce,' 'Homines hi." The above forms, according to Champollion and other investigators of ancient hieroglyphics, occur in the oldest known monumental inscriptions, showing plainly that the ideas of the ancient Egyptians as to the method of expressing the category 'to be' did not accord with those of some modern grammarians. . . . . Every Semitic scholar knows that personal pronouns are employed to represent the verb substantive in all the known dialects, exactly as in Coptic, but with less variety of modification. . . . . The phrase 'Ye are the salt of the earth' is in the Syriac version 'You they (*i. e.*, the persons constituting) the salt of the earth.' Nor is this employment of the personal pronoun confined to the dialects above specified, it being equally found in Basque, in Gala, in Turco-Turanian and various American languages. . . . .

"Malayan, Japanese and Malagassy grammarians talk of words signifying to be; but an attentive comparison of the elements which they profess to give as such, shows clearly that they are no verbs at all but simply pronouns or indeclinable particles commonly indicating the time, place or manner of

[1]Garrett on the Nature and Analysis of the Verb. Proc. Philo. Soc., Vol. iii.

the specified action or relation. . . . A verb substantive such as is commonly conceived, vivifying all connected speech and binding together the terms of every logical proposition, is much upon a footing with the phlogiston of the chemists of the last generation—*vox et praterea nihil.* . . . If a given subject be 'I,' 'thou,' 'he,' 'this,', 'that,' 'one;' if it be 'here,' 'there,' 'yonder,' 'thus,' 'in,' 'on,' 'at,' 'by;' if it be 'sits,' 'stands,' 'remains,' or 'appears' we need no ghost to tell us that it *is*, nor any grammarian or metaphysician to proclaim that recondite fact in formal terms."

It seems then that no more unfortunate point could have been chosen than the use of the verb "to be" as constituting the Rubicon of mind; it has only served to accumulate proofs that there is no Rubicon in the sense of a distinct barrier between the minds of men and animals, and that if a dividing line be arbitrarily drawn it must be not between man and brute, but between the lower animals, young children and savages on the one hand and civilized man capable of true abstract ideas on the other.

A young child has made a distinct step in advance when he speaks of himself in the first person. But many tribes of savages have never yet risen to this consciousness of the "ego;" but for such an expression as "I will eat the rice" we have recourse to the form "The eating-of-me-the-rice."[1]

If a child exclaims "black man" at the sight of a negro he expresses the same idea that we do in saying "that man is black;" if he says "dit ki" (sister is crying), "dit dow ga" (sister is down on the grass), "dat a big bow-wow" (that is a large dog),[2] he is implicitly predicating certain facts and forming certain judgments precisely as if he formally used the copula. "The child perceives a certain fact and states the perception in words *in order to communicate information of the facts to other minds*, just as an animal under similar circumstances will employ a gesture or vocal sign." A cat cannot express in words the ideas "my kitten is shut in a drawer;

[1]Malayan and Polynesian Languages. Mental Evolution of Man, p. 313.

[2]See p. 203, Mental Evolution of Man.

you can take it out if you come;" but she can eloquently express her meaning by vocal signs and gestures.

Another clue to the evolution of language may be found in the sign language of educated deaf-mutes and its grammatical construction. The deaf-mute does not make the statement "bring a black hat," but "hat black bring;" not "I am hungry, give me bread," but "hungry, me bread give." The Abbé Sicard says: "A pupil to whom I put this question, 'who made God?' replied 'God made nothing.' I was accustomed to this inversion usual amongst the deaf and dumb, and I went on to ask him 'who made the shoe?' and he answered, 'the shoe made the shoemaker.' Laura Bridgman would spell on her fingers 'that door,' 'give book,' which she had been taught, but when she made sentences for herself she reverted to the usual deaf-and-dumb system, 'Laura bread give,' 'water drink Laura,' to express her wish to eat or drink."

Mr. Tylor says: "The gesture language has no grammar properly so-called; it knows of no inflections of any kind more than the Chinese. The same sign stands for 'walk,' 'walkest,' 'walking,' 'walked,' 'walker.' Adjectives and verbs are not readily distinguished by the deaf-and-dumb. 'Horse, 'black,' 'handsome,' 'trot,' 'canter,' would be the rough translation of the signs by which a deaf-mute would state that a handsome, black horse trots and canters. The deaf-mute strings together the signs of the various ideas he wishes to connect, in what appears to be the natural order in which they follow one another in his mind, *for it is the same among the mutes in different countries,* and is wholly independent of the syntax which may happen to belong to the language of their speaking friends.

With regard to the sign language of Indians Mr. Tylor says: "There is no doubt that the Indian pantomine is not merely capable of expressing a few simple notions, but that to the uncultured savage, with his few and material ideas, it is a very fair substitute for his scanty vocabulary." Forty-three examples of this gesture language are given, collected by Mr. Pehoff, as occurring between Indians of different tribes. Colo-

nel Mallery in his Dictionary of Indian Signs observes: "The sign language of the Indians, and the gesture system of deaf-mutes, and of all peoples, constitute together one language—the gesture speech of mankind—of which each system is a dialect."

In Italy the power of expression by pantomine is particularly strongly developed, and whole plays are carried out through the use of gestures alone, and are thoroughly enjoyed by the people. Even in England, where gestures are less used than in any other country, one is astonished at the number of ideas which we can, and do, express by gestures. Knowing the strong influence of atavism, it is a legitimate deduction from the world-wide prevalence of gesture language that gestures formed an important part of the original means of communication between human beings, and if we are to judge from ontogeny, preceded the imitation of sounds in nature and the arbitrary invention of words, and developed *pari parsu* with the original howls and shrieks of primitive man. Tribes still exist whose words are unintelligible without the aid of gesture, and who are unable to carry on a conversation in the dark.

Researches into the mental faculties of civilized children and uncivilized men, as well as into the mental faculties of the highest animals, such as the elephant, the monkey and the dog, show, as was said at the beginning of this article, a difference of degree but not of kind. Immense is the distance between the mind of a Shakespeare or a Newton and the mind of a Hottentot. But the distance is also immense between the green scum, the one-celled alga of our ponds and ditches and the lordly oak; yet each belongs to the vegetable kingdom, and there is no break in the innumerable forms which fill up the wide space between the pond scum and the oak.

With regard to the theory that language is a divine gift from the very beginning bestowed upon man and denied to the lower animals, some light is thrown by the condition of what may be called 'relapsed man;' those cases where children have either been reared by and with wild animals or

have run into the woods when young and managed to survive.

An instance recently occurred on Mount Pindus, in Thessaly. The warden of the King's forest on Mount Pindus was strolling up to a shepherd's hut whilst on a shooting expedition, to procure a drink of milk. He heard a rustling in the bushes, and was raising his gun when the shepherd called out to him not to shoot. He saw a naked creature in the form of a man running in front of him, sometimes on its feet, more often on all fours. It reached the hut and began eagerly sucking up the buttermilk out of a trough into which cheeses had been pressed. The shepherds said the child was a Wallachian by birth. His father died, and his mother, distributing her children amongst her neighbors, went back to her own country. This boy had escaped into the woods and had kept himself alive there for four years. In the summer he drank buttermilk daily and 'lived well;' in the winter he took shelter in the caves and eat herbs and roots. The warden, pitying the child, bade the shepherds catch and bind him with a rope and then took him to his home at Trikala. Here he fed and clothed his little Orson, and placed him with a person who endeavored to teach him to talk, or kept the child when possible under his own charge. But the boy has *never learned to speak a word*, though he imitates the voices of many wild creatures.[1] The same inability to speak has been shown in the cases of other 'wild' children found in India, collected by Colonel Sleeman, the able officer who helped to suppress thuggism. In a district near the Goomtee River in the Province of Oude, wolves are never killed by the villagers from a fear of the ill-luck which their death might bring upon the village, and wolves consequently abound. A native trooper saw a large she-wolf leave her den, followed by three whelps and a little boy, all on their way to the river to drink. When chased by the trooper they all escaped to their den, the boy running on all-fours as fast as the young wolves. The whole party was dug out; the wolves were dug out and bolted; the boy was caught, bound with a rope, and

[1]See Spectator, Jan. 9th, 1892.

after four days sent to an English officer, Captain Nicholetts. He was kindly treated, but he never learned to speak: he would fly at children and try to bite them, and ran to eat his food on all-fours. But he was friendly with a pariah dog, and would let him share his food. He would suck up a whole pitcher of milk. He never laughed or smiled, destroyed all his clothes, and in two years and a half ended his short life of piteous degradation, speaking once or twice as he lay dying, the words for water and aching head. Another child, caught in the same neighborhood, was even more savage, and would only eat raw flesh, on which he put his hands as a dog puts its fore-feet. His knees and knuckles were quite hard with running on all-fours. He was quite untamable, and at last lived in the village street with the pariah dogs, going every night into the jungle. A third boy, caught at Hasanpur, exhibited the same characteristics, his favorite playmates being the jungle wolves, which would caper round him and lick him. In all these cases the characteristics of relapsed man are the same: he walks and runs well on all-fours, cannot be taught to speak, lives on raw food, and drinks by suction, as a horse or cow drinks.

Now if language be a God-given endowment exempt from the usual laws of evolution, a wild boy with uninjured brain should be able to learn to speak readily; indeed, he should be able to evolve some form of speech by himself. If, however, articulate speech is the result of long ages of evolution from speechless ancestors we can understand that the centre for articulate speech in the human brain requires stimulating and cultivating from early infancy; and if not so stimulated and cultivated will fail to exercise a faculty acquired *comparatively* late in the evolution of the species. With regard to other characteristics, every little child goes on all-fours, and not like any other animals, on the toes or soles of the feet, but on the knees. And every infant at first tries to "drink like a calf," putting its mouth *into* a cup to suck up the milk, and only slowly learning to drink from the edge.

It seems to me that the weight of evidence afforded by facts is in favor of the hypothesis that the human mind has fol-

lowed the laws of evolution like everything else we know of in the universe; and that the apparent abyss between the intellect of man and that of the lower animals lies, as I have said before, in the nature of the organ which has been specially evolved in *Homo sapiens.*

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MINERALOGY AND PETROGRAPHY.[1]

The Basalt of Stempel.—Bauer's[2] description of the basalt of Stempel, near Marburg, and its concretions and inclusions is one of the most excellent pieces of petrographical work that has appeared in a long time. A favorable opportunity has enabled the author to secure a splendid suite of specimens of this rock so noted for its beautiful zeolites. It consists of the usual constituents of basalt, viz.: plagioclase, augite and olivine in a groundmass of augite and feldspar microlites in a base of glass. The plagioclase is andesine without peculiar characteristics. The augite is also without special features except that it is frequently zonally developed, with a dark-green kernel and brown-colored coats, in which the extinction decreases from 48° to 36°. The olivine is so well bounded by crystal planes that the relations of the shapes of the cross-sections to the crystallographic axes have been well worked out. Twins parallel to $P\breve{\infty}$ are not uncommon. The liquid inclusions, upon careful study, are found to differ from those of the olivine of the concretions (Knollen), and the glass inclusions are learned to have a different composition from the glass forming the groundmass of the rock. One of the most interesting features of the rock is the occurrence of amygdaloidal cavities, coated within by a layer of glass, whose limits are sharply defined. Sometimes a partition of this glass divides a cavity into two, and occasionally several concentric partitions give rise to a series of chambers that are strikingly like the chambers in Idding's lithophysae. The olivine bombs included in the rock consist largely of bronzite and chrome-diopside grains cemented by olivine substance. The bronzite is present in two varieties, one an almost opaque greenish-brown kind, and the other a transparent olive-green variety. Picotite is also present quite abundantly in grains and aggregates of grains in most of the bombs. The effect of the action of the rock magma upon its inclusions is seen in the granulation of the pyroxenes, and the effect of the material of the bombs upon the magma is shown in the presence of microlites of hypersthene in the veins of the rock that ramify the bombs. Since the minerals of the bombs contain characteristic inclusions not common to lherzolitic rocks, and since, moreover, the olivine and bronzite are sometimes found in forms never seen in lherzolite, the author

[1]Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2]Neues Jahrb. f. Min., etc., 1891, ii, p. 156.

concludes that these bodies are not inclusions torn from a deep-seated basic rock as is sometimes thought, but that they are concretions of the basic minerals of the basalt, formed during the intratellurial period of its magma's history. Another interesting feature of the Stempel occurrence is the abundance and variety of true inclusions found therein. These are limestone, quartz, feldspar and amphibolite fragments and others torn from a cordierite rock. The limestone has produced but little effect upon the surrounding rock other than rendering its texture coarser by increasing the size of its feldspathic constituents. The limestone itself has suffered little change. The quartz fragments are all surrounded by rims of green augite crystals, and in their interior they are filled with swarms of cavities either empty or filled with liquid. Sandstone inclusions now consist of grains of quartz, cemented by a glass that has originated in the fusion of the cement of the original rock. This glass sometimes contains trichites and magnetite grains, when it is colorless; sometimes it is devoid of them and is colored brown. The glass cement also frequently contains drops of glass that differ from the enclosing material in that it dissolves readily in hydrochloric acid, while the latter is unaffected by this reagent. The included substance is regarded as the pure glass produced by the solution of the cement of the sandstone, while the insoluble variety is that to which silica has been added by the corrosion of the quartz grains. The finer grained sandstones have yielded basalt-jasper. In their glassy constituent are numerous crystals of apatite that are similar in most of their properties with the nepheline and cordierite crystals observed by Zirkel in some of the basalt-jaspers described by him. The orthoclase inclusions are penetrated by tiny veins of glass. Both the feldspar and the glass contain small violet octahedra of some spinel and blue pleochroic needles of glaucophane, while tridymite plates occur in the latter substance. An aggregate of orthoclase and plagioclase contains flecks of green glass between the grains that is thought to be fused mica, while the feldspar is filled with sillimanite needles. The other inclusions present features that are worthy of notice, but they cannot be described in the present place. The article will well repay the reader for its perusal.

The Crystalline Rocks of Tammela, Finland.—The archean rocks in the vicinity of Tammela, in the South-western part of Finland, are crystalline schists, granites, gabbros, porphyrite and vitrophyres. A gray granite, Sederholm[1] thinks, is closely related to the

[1]Min. u. Petrog. Mitth., xii, p. 97.

gabbros and diorites of the region, which appear as though basic separations from the same magma as that yielding the granite. The most abundant rock is a muscovite granite. Next in importance is a uralite-porphyrite, whose uralitic phenocrysts are complete pseudomorphs of augite. All the constituents of the rock show much alteration. The plagioclase is changed to epidote and zoisite, and between the secondary products of this mineral are newly formed plagioclase and hornblende, and in addition there are frequently accumulations of biotite, whose form leads to the supposition that they are pseudomorphs after olivine. In its original condition this rock was probably a basalt. A plagioclase-porphyrite, an amygdaloid and glassy rocks with the composition of an acid basalt also occur in the region. Tufas accompanied the outflow of basalt, but in this as in the other rocks described the character of the original substance has been greatly obscured by alteration. In discussing the cause of the chemical changes that have been effected, the author ascribes the most powerful action to water in connection with pressure. Many of the rocks show evidences of dynamo-metamorphism. A schistosity has been superinduced in nearly all of the types, but the crushing and breaking of grains that are such striking phenomena in most instances of this kind, are here absent. The pressure exerted its influence principally in increasing the solvent power of the water. Very little change in the chemical composition of the rocks has resulted from the alteration, in spite of the fact that their mineralogical composition has been totally changed.

Petrographical Notes.—The breccias and porphyries of Pilot Knob, Mo., have repeatedly been stated to be metamorphised fragmentals. Haworth[1] has examined their relations to other rocks and has carefully studied their thin sections with the result that they are pronounced by him true eruptives, the latter, quartz-porphyries, exhibiting flowage structure, and other evidences of having once been liquid, and the former, porphyry breccias, with fragments of porphyry cemented by a groundmass that was once a fluid volcanic lava.—— Cordierite-bearing chiastolite schists are briefly mentioned by Klemm[2] as forming part of the contact belt of the Lausitz granite at Dubring, and dykes of hornblende-porphyrite as cutting the granite at this place and at Schmerlitz, in Saxony.——In a brief communication Kemp[3] speaks of the existence of several dykes of a very much altered

[1]Bull. No. 5, Geol. Surv. of Mo., p. 5.

[2]Zeits. d. d. Geol. Ges., xliii, 1891, p. 526.

[3]Amer. Jour. Sci., Nov., 1891, p. 410.

peridotite in the Portage sandstones near Ithaca, N. Y.——In a hornblende-andesite inclusion in the Capucin trachyte Lacroix[1] finds one cavity containing magnetite, biotite, fayalite and hypersthene—a different association of minerals from that in any other cavity. The most interesting of these minerals is the fayalite, which occurs in tiny crystals with a golden yellow color, due to a ferruginous pigment.

Mineralogical News.—A series of new analyses of *amarantite* from the Mina de la Campania, near Sierra Corda, Chile, give: $SO_3 = 35.46$; $Fe_2O_3 = 37.46$; $K_2O = .11$; $Na_2O = .59$; $H_2O = 28.29$, corresponding to $Fe_2\ S_2O_9 + 7H_2O$. The mineral has a specific gravity of 2.286, and at 110° it loses three molecules of water. Its axial ratio as determined by Penfield[2] is $a : b : c = .7692 : 1 : .5738$ with $\alpha = 95° \ 38' \ 16''$; $\beta = 90° \ 23' \ 42''$, $\gamma = 97° \ 13' \ 4''$, and $2E_{na} = 63° \ 3'$. In sections parallel to the trachy-pinacoid the extinction is 16°–17° in acute β. *Sideronatrite* from the same place occurs in fine orange or straw-yellow fibres, with orthorhombic symmetry (not monoclinic as Raimondi asserts). Its density is 2.355. A mean of several analyses yielded:

$$\begin{matrix} SO_3 & Fe_2O_3 & Na_2O & H_2O \\ 44.22 & 21.77 & 16.39 & 17.07 \end{matrix} = 2Na_2\ SO_4\ Fe_2\ S_2O_9 + 7H_2O.$$

The mineral suffers a loss of four molecules of water at 110°. Associated with sideronatrite are little white masses composed of a substance with hexagonal optical properties. It is positive with $\omega = 1.558$, $\varepsilon = 1.613$ for yellow light. Its density $= 2.547–2.578$, and its composition is: $H_2O = 11.89$; $SO_3 = 51.30$; $Fe_2O_3 = 17.30$: $Na_2O = 19.63$; $K_2O =$ ca. .16, corresponding to $3Na_2\ SO_4,\ Fe_2(SO_4)_3 + 6H_2O$. With these analyses are also given those of a *picropharmacolite* from Joplin, Mo., of *pitticite* from the Clarissa Mine, Utah, of *gibbsite* from Chester Co., Pa., and of *atacamite* from Chile. The analysis of the first mentioned mineral leads to the formula $(H_2\ Ca\ Mg)_3\ As_2\ O_8 + 6H_2O$. The pitticite gave: $H_2O = 17.64$; $As_2O_5 = 39.65$; $Fe_2O_3 = 33.89 = 4Fe_2(As\ O_4)_2.\ \ Fe_2(OH)_6 + 20H_2O$. The mineral is not a mixture of the sulphate and arsenate of iron as is the German variety. No definite conclusion was reached as to the composition of the gibbsite other than that it is a hydrous aluminum phosphate.——Though *columbite* has been known to exist in the Black

[1]Bull. Soc. Franc., d. Min., xiv, p. 10.

[2]Zeits. f. Kryst., xviii, p. 585.

Hills in Dakota for some six years past, the first accurate account of its occurrence and of its composition has but just been communicated by Mr. Headden.[1] The mineral together with *tantalite* is often present in the stream tin of the hills. It is also found imbedded in beryl at the Etta Mine and associated with other minerals at the various other mines in the district. Fourteen analyses of crystals obtained from the different localities are given. Some of these correspond with the formula $3R\ Cb_2O_6 + 2R\ Ta_2O_6$, with $R = Fe_{\frac{1}{2}}\ Mn_{\frac{1}{2}}$. As the density of the mineral becomes greater the proportion of tantalum to columbium increases, passing from 1 : 6 to 1 : 1¼; thus indicating that columbite and tantalite are isomorphous substances. Analyses follow: I. Turkey Creek, Col.; II. Yolo Mine, S. Dak.; III. Tantalite, associated with stream tin at the Grizzly Bear Gulch, S. Dak.; IV. Manganiferous columbite, from Advance Claim, 1½ miles S. of Etta Mine.

	Cb_2O_5	Ta_2O_5	SnO_2	WO_3	FeO	MnO	CaO	Sp. Gr.
I.	73.45	2.74	.21	1.14	11.32	9.70	.61	5.383
II.	24.40	57.60	.41		14.46	2.55	.73	6.592
III.	3.57	82.23	.32		12.67	1.33		8.200
IV.	47.22	34.27	.32		1.89	16.25		6.170

Mr. Headden's results are interesting as indicating the widespread occurrence of these two rare minerals in the Black Hills region, and his paper is valuable for the great number of analyses contained in it. ——Laspeyres[2] has reexamined the *saynite* (of V. Kobell) from Grube Grüneau, in Kirchen on the Sieg, in Germany, where the mineral occurs in crystals. He finds it to be a mixture of polydymite with other sulphides, as he declared it to be some time since. *Ullmanite* crystals from Siegen, in the same neighborhood, are described as consisting of cubes with striations parallel to the pyritoid edge, or of cubes, dodecahedrons and octahedrons combined with more complicated forms, among which are many parallel hemihedral ones. Its crystallization thus corresponds with that of the Sardinian Ullmanite described by Klein.[3] A rare chance was also afforded Laspeyres for the study of the crystallization of *wolfsbergite*, from Wolfsberg, in the Harz. The new crystals obtained by him are tabular parallel to oP,

[1] Amer. Jour. Sci., Feb., 1891, p. 89.

[2] Zeits. f. Kryst, xix, 1891, p. 417.

[3] Neus. Jahrb. f. Min. etc., 1883, i, p. 180 and 1887, ii, p. 169.

and have the macro-zone more highly developed than the brachy-zone. They show clearly that Groth is correct in regarding the mineral as isomorphous with amplectite, scleroclase and zincenite. The axial ratio, calculated from pyramidal faces that gave good reflections, is $a : b : c = .5283 : 1 : .6234$.——The little-known members of the *mesotype* group on the Puy-de-Dôm have recently been described by Gonnard[1] in some detail as regards localities. An analysis of the natrolite from the Puy-de-Maman yielded: $SiO_2 = 48.03$; $Al_2O_3 = 26.68$; $Na_2O = 15.61$; $H_2O = 9.62$; and that of the Tour de Gevillat gave: $SiO_2 = 47.88$; $Al_2O_3 = 26.12$; $Na_2O = 15.63$; $CaO = .45$; $H_2O = 9.80$.——The same author[2] has made a crystallographic study of the *barites* of the Puy-de-Dôm. All crystals of this substance are beautifully modified but none show new forms. A peculiarly habited *aragonite*[3] from the Neussargnes Tunnel, Cantal, contains the new forms $\frac{13}{3}P\breve{\infty}$ and $\frac{3}{2}P$.——The investigation of the nature of the nitrogen found in *uraninite*, promised some time ago, has been continued by Hillebrand[4] without, however, very great success. The most careful analyses of specimens from Glastonbury, Ct., and from Arendal, Norway, yield respectively:

UO_3	UO_2	ThO_2 etc.	PbO	CaO	H_2O	N	Fe_2O_3	SiO_2	Insol.	Sp. Gr.
23.03	59.93	11.10	3.08	.11	.43	2.41	.29	.16	.89	9.622
26.80	44.18	13.87	10.95	.61	undet.	1.24	.24	.50	1.19	

The principal result of the analyses is to the effect that all uraninite contains more or less nitrogen, sometimes amounting to as much as $2\frac{1}{2}\%$. The condition in which the element exists is unknown, but it is probably different from any hitherto observed in the mineral kingdom. Another result indicated is that the formulas that have been accepted as expressing the composition of the mineral do not do so. Specimens from many of the classical localities have been analyzed, and in nearly every case errors have been detected in the original analyses. The author concludes that while uraninite in general contains the same constituents, it varies widely in composition, and its physical characteristics are often as distinct as are the chemical differences.——The *keramohalite* from Pico de Teyde, in the Canary Isles, is in little imperfectly developed crystals imbedded in a yellowish white hygroscopic

[1]Bull. Soc. Franç. d. Min., 1891, xiv, p. 165.

[2]Ib., xiv, p. 174.

[3]Ib., xiv, p. 183.

[4]Bull. U. S. Geol. Survey, No. 78, p. 43.

granular mass, in the neighborhood of solfataras. The soluble substance extracted from this mass by Hof[1] gave:

SO_3	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	H_2O
38.62	13.96	.94	.66	.22	.04	2.37	42.01

The form of the crystals as determined by Becke[2] is tabular parallel to $\infty P\grave{\infty}$. They have a weak negative double refraction. The axis of mean elasticity is inclined 48° to $\infty P\overline{\infty}$, and that of the least elasticity 13° to $+P\overline{\infty}$. The crystallization is monoclinic with $a : b : c =$ 1 : ? : .825 $\beta = 97° 34'$.——In the druses of a massive *garnet* used as a flux in the copper smelters at Kedobek, Caucasia, are found crystals of garnet that rival in beauty the famous Tyrol varieties. They are bounded by the forms 2O2, ∞O and occasionally $3O\frac{3}{2}$, and all the faces are brilliant. Their color is wine to honey-yellow and their composition[3] is represented by:

SiO_2	CaO	Al_2O_3	Fe_2O_3	Loss	
39.12	35.84	22.73	1.76	.15	$= Ca_3\ Al_2(SiO_4)_3$.

——According to Branner[4] inexhaustible beds of *beauxite* occur near Little Rock and Benton, Ark., that are supposed to be genetically related in some way with eruptive granites. The material is pisolitic in structure. The composition of one variety as shown by a partial analysis is:

Al_2O_3	SiO_2	Fe_2O_3	TiO_2	Loss
55.64	10.38	1.95	3.50	27.62

——The handsome *calcite*[5] twins from Guanajuato, Mexico, that have been known for some time, are usually the scalenohedron R^3, twinned parallel to $-\frac{1}{2}R$. Corresponding pairs of faces on each individual are so developed that their combination has a monoclinic habit, resembling strongly the swallow-tailed twins of gypsum. The forms recognized in the crystals are mentioned in the paper and six figures accompany it.

[1]Min. u. Petrog., Mitth. xii, p. 39.

[2]Ib., p. 45.

[3]Müller: Neues. Jahrb. f. Min., etc., 1891, i, p. 272.

[4]Amer. Geologist, vii, 1891, p. 181.

[5]Pirsson: Amer. Jour. Sci., Jan., 1891, p. 61.

——Frenzel[1] has made a new analysis of *gordaite* and has found it to be identical with ferronatrite, while Arzruni has examined its crystals and declares them to be rhombohedral with $a : c = 1 : 55278$.——C. Schneider[2] gives good analyses of six basaltic hornblendes, all of which contain over 4% of TiO_2.

[1]Zeits. f. Kryst., xviii, p. 595.

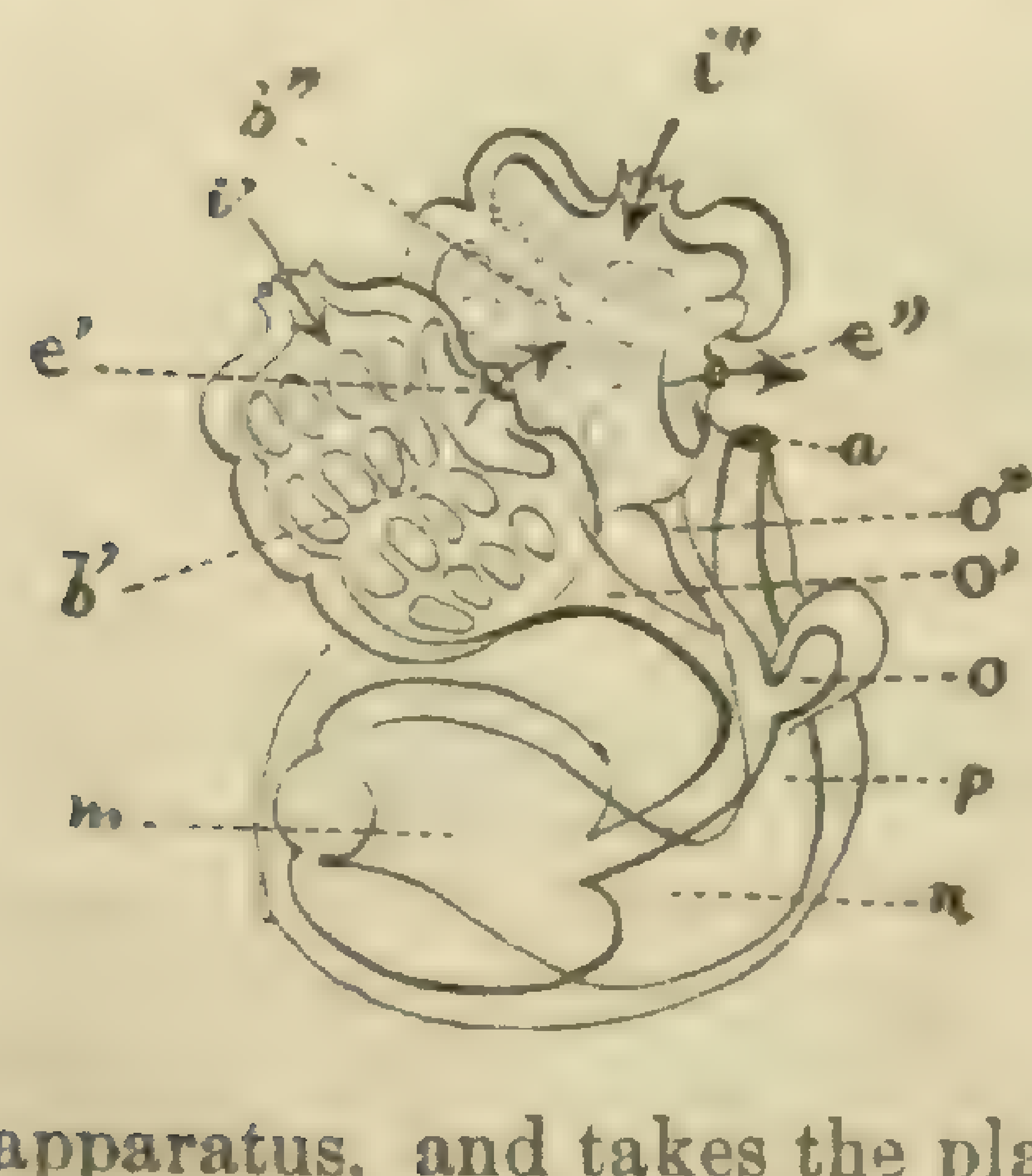
[2]Zeits. f. Kryst., xviii, p. 579.

ZOOLOGY.

Temperature and Color in Lepidoptera.—At the meeting, March 24, 1892, of the South London Entomological and Natural History Society, Mr. F. Merrifield exhibited examples of *Selenia illustraria, S. illunaria, S. lunaria, Vanessa urticæ, Platypteryx falcataria, Chelonia caia, Bombyx quercus* and var. *callunæ*, to illustrate the effects of temperature on these species. He prefaced his remarks by referring to the experiments of Weismann and Edwards which were made on seasonally dimorphic species, and said that his results were consistent with those of these gentlemen; but he went further than they did, and he found that by subjecting the pupæ to certain temperatures he invariably, in the majority of specimens, obtained certain results, a lower temperature generally producing darker and more intense colors than higher temperatures. In *illustraria*, a brood divided into two portions, and one placed at a temperature of about 80°, produced normal specimens, while the other portion, placed at 50° or 60° were strikingly darker in color. The same results, but in less degree, were obtained with other forms. In *V. urticæ* some of the examples closely approached var. *polaris*, the specimens exposed to the lower temperature being generally darker and the blue crescents more intense in color. In conclusion Mr. Merrifield said that a temperature of 47° seemed to stunt the size and produced a large proportion of cripples, and higher temperatures than this seemed more conducive to health and vigor. It had been suggested that the results he obtained were attributed to the unhealthy conditions to which the pupæ were exposed, but this was not at all a correct explanation; in the 172 specmens he exhibited 150 were not cripples. Extreme temperatures produced crippling, but moderate temperatures were quite sufficient to account for the extreme difference in coloring. Mr. Fenn said he had since 1859 paid great attention to the earlier stages of Lepidoptera, and he assumed that variation was either natural or artificial. Natural variation might again be divided into three nearly equal causes: heredity, moisture and natural selection. In artificial selection the causes might generally be said to be abnormal or diseased. By disease he meant a general weakening of the constitution by unnatural influences; the least deviation from natural conditions might produce variation. Mr. Fenn had had considerable experience in breeding *E. autumnaria*, one of the species relied on, and in the series he exhibited

there were many paler and many darker than any shown by Mr. Merrifield; and the larvæ and pupæ had been kept under usual conditions, and the greater proportion of them followed the parent forms. In conclusion he said that such variation as was shown by Mr. Merrifield was impossible in nature except as a result of disease. Several gentlemen continued the discussion, Mr. Tutt following Mr. Fenn in attributing the variation to disease, and saying that to a large extent it was caused by preventing the proper development and formation of the coloring pigment. He thought the action of temperature indirect, producing variation by interfering with the normal development. Mr. Merrifield agreed with many of Mr. Fenn's observations and thought most of them consistent with his own experiments. In any case he thought that in the species studied by him the temperature was so moderate as not to interfere with health, and yet it produced, with great uniformity, considerable differences in color. In some other species no considerable changes were produced unless the temperature was so extreme as to produce crippling or imperfect development.—(Entom. Monthly Magazine.)

A Curious Compound Ascidian.—In a current number of a Japanese zoological journal,[1] Mr. A. Oka, now of Freiburg, i | Br., Germany, describes an interesting phenomenon in the life of a compound Ascidian, *Diplosoma*, which he collected some years ago at Misaki, Japan. As an examination of the accompanying diagram



will show, the œsophagus of each individual Ascidian is divided into two branches (o′ and o″), each branch terminating in one branchial basket (b′ and b″) respectively. The branchial basket indicated by the dotted line (b″) is old, while the other basket (b′) is young and functional. On the other side of the œsophagus is represented a young bud (o) which, when fully unfolded, becomes a functional branchial apparatus, and takes the place of (b′); the oldest basket (b″) having disappeared by that time. Various intermediate stages indicating this state of transition have been observed. In such forms the œsophageal end of the alimentary canal shows division into three branches. The

[1] *The Zoological Magazine* (Japanese), vol. iv, no. 42, pp. 144–146, April 15, 1892. Tokio, Japan.

anus (a) opens in *Diplosoma*, as in *Appendicularia*, independently by itself; hence, the anus does not share with the branchial basket the phenomenon of occasional regeneration, but persists throughout life. In one individual, then, such as is shown in the accompanying diagram, there exist five openings, *viz.*, the old incurrent pore (i″), the old excurrent pore (e″), the young incurrent pore (i′), the young excurrent pore (e′) and the permanent anus (a).

This regeneration of a complete organ, not as a result of artificial mutilation of the organism, nor as the result of the removal of any part, but as a result of a normal physiological process is very remarkable. Mr. Oka thinks it similar to certain phenomena common in the vegetable kingdom.—(Translated and abstracted by Dr. Watase, Clark University.)

The Development of the Teeth of Man.—Dr. Carl Röse has studied the development of human teeth and comes to the following conclusions.[1] The first trace of the primary dental ridge appears simultaneously (34–40 days) in both jaws. It is in section a semicircular ingrowth of not yet differentiated cells of the epithelium of the jaw. It appears at the same time with Meckel's cartilage. At about 48 days (17 mm) the primary dental ridge splits into two ridges lying at right angles to each other. Of these the one going vertically into the jaw is the labial groove ridge, the other, going horizontally into the jaw, is the true dental ridge. The deepest layer of the epithelium is of high cylindrical cells. The labial groove ridge continues to grow deeper while its upper layer becomes resorbed, thus giving rise to the furrow between the lip and the jaw, the process beginning at the middle and extending each way. The slight dental groove which runs along the line of the union of jaw epithelium and dental ridge is at first on the outer surface of the jaw and gradually wanders in a spiral line over the jaw to the posterior surface, the middle advancing more rapidly than the sides.

The dental ridge which at first was horizontal changes its position as a result of the growth of the milk teeth, and becomes more and more vertical. Its free edges become produced into undulatory outgrowths, ten in number, which become spherical and form the first anlagen of the milk dentition. At the tenth week (embryo of 32 mm length) there begins simultaneously, or in quick succession, the pushing in of the papillæ into these outgrowths, *and these connective tissue*

[1]Arch. f. mikr. Anat. xxxviii, 447, 1891.

papillæ do not push into the deepest but into the lateral portion. In this way the dental ridge can continue its growth behind the milk-teeth unhindered by the process of separation of these teeth, which begins in the fourteenth week. At the same time the ridge shows irregular outgrowths and three weeks later these have become more evident, and in the region of the incisors a partial fenestration of the ridge is begun.

At the twenty-fourth week the dental ridge, in the region of the anterior teeth, has become converted into a sieve-like plate with irregular projections; in the molar region it is as yet smooth and unbroken and its under margin retains the thickened and undulating character. In front of and mesial to these thickenings are the milk teeth, and from the side of these milk teeth the papillæ of the permanent teeth (the incisors first) encroach upon the thickened margins of the dental ridge. The dental ridge grows behind the second milk molar in the fourteenth week and at the seventeenth its end is thickened, and from this thickening is developed the first permanent molar.

At the time of birth the ridge extends behind the first molar as a short thickened plate which at the sixth month has extended farther backward and has become thickened for the second molar which is formed as before. In the child of three and a quarter years the condition behind the second molar is like that in the child at birth, behind the first molar. The wisdom tooth arises about the fifth year by a lateral ingrowth like that of the other molars. Owing to the extraordinary adaptability of the dental ridge there is a possibility of a fourth molar behind the wisdom tooth and also of a third dentition in the anterior portion of the jaws.

Odontogenesis in the Ungulates.—Julius Laecker, of the Veterinär Institut of Dorpat, has just completed a most interesting series of studies upon Odontogenesis in the Ungulates. He undertook their investigation with the purpose of determining how far the embryological development of the crowns of the molar teeth repeats the palæontological development, and especially to test the theory of bunodont origin advocated by Cope and Gaudry as opposed to the earlier Rütimeyer-Kowalevsky hypothesis that the primitive molars of ungulates were crested or lophodont. His method of research was an improvement of that introduced by Klever[1] upon the molars of the horse but his material included not only embryos of the horse, but

[1] "Zur Kenntniss der Morphogenese d. Equidengebisses," Morph. Jahrb. xv, p. 308, 1889.

of the pig as a modern bunodont, and as selenodont types a number of elk (*Alces palmatus*) embryos, one stage of the deer (*Capreolus capræa*), abundant material of the ox and sheep as hypselenodont types, and of even greater interest, an embryo of one of the rare and transitional ancient group of Tragulidæ. As, in course of his investigation, he found abundant evidence in support of the remote tritubercular origin of these modern highly modified teeth, he adopts Cope's theory and Osborn's nomenclature and homologies, so that the reader can readily compare his plates and descriptions with the palæontological series as recently figured by Cope, Scott, Lydekker, Schlosser and others.

We may now quote his conclusions: "As a result of my investigations it is evident that both the bunodont Suidæ, and selenodont ruminants present a closely similar initial bunodont stage; according to which the Cope–Osborn opinions are in general conformed by embryological data, although in many points, especially as regards the (more elevated position of the) protocone, ontogenesis is no longer parallel with phylogenesis.

2. The differentiation soon follows whereby the separate cones and conids in the pig transform into pyramids and in the ruminants into crescents.

3. The transformation of the cones affects the separate cones in succession, not beginning with the protocone but with the earlier developed paracone. [The author has unconsciously strengthened his proof here, for it is well known that in the fossil series, the external upper cusps, i. e., the paracone and metacone, assume the selenoid form earlier and more universally than the protocone.]

4. In the last two upper deciduous premolars (D^4 D^3) from an originally conic metacone is developed a tooth with two cones, by the addition of the paracone; then, in D^4 at least, appears the protocone and finally the hypocone. In D^3 the protocone is the last cusp added. [Here again the author demonstrates an approximate parallelism between the ontogenesis and phylogenesis; he is evidently not aware of the observation of Schlosser that the upper premolar cusps do not appear in the same order and are therefore not homologous with the molar cusps. The actual order of evolution of the premolar cusps was observed by Osborn[1] in *Hyracotherium* as follows: A cusp *analogous* with the paracone (really the protocone) first appears, then the outer cusp divides into two, paracone and metacone,

[1] MSS. of chapter upon the *Equidæ* for the "American Fossil Mammals."

or more commonly the protocone appears second, and the metacone third, then the protoconule appears, the hypocone, followed finally by the metaconule. Similarly the lower premolars do not repeat the ancestral lower molar history, the order is protoconid, hypoconid, metaconid, entoconid. "Scott[1] has worked this out in the Artiodactyla as follows: *4th. upper premolar*—paracone (protocone), protocone deuterocone), metacone (tritocone), hypocone (tetartocone). *4th. lower premolar*—protoconid, metaconid (deuteroconid), hypoconid, entoconid.] Turning again to Laeker's investigation we find that:

5. In the lower jaw the fourth milk molar the order is protoconid, ? paraconid, (anterior cusp) hypoconid, metaconid, entoconid. [The homology of the paraconid is somewhat uncertain.]

In considering the exceptions between ontogenesis and phylogenesis here noted, we must remember the extreme antiquity of some of these structures, dating back to the middle and lower Eocene, for upon the whole the parallelism is most striking.—HENRY F. OSBORN, American Museum of Natural History, New York, May 23rd, 1892.

[1] "Osteology of *Poëbrotherium*," Journ. of Morphology, June 1891, pp. 48–49.

EMBRYOLOGY.[1]

On the Significance of Spermatogenesis.[2]—Auerbach has recently shown that a characteristic of the ovum and of the sperm is the fact, that the nucleus of the former takes on a red color, while that of the latter takes a blue, when both are treated exactly in the same way; to use Auerbach's expression, the hereditary substance of the male is *cyanophilous*, while that of the female is *erythrophilous*. I have tried this method of differentiating the sexual cells in the following animals: Asterias, Loligo, Unio, Limax, Rana, Bufo, Necturus, Diemyctylus, Mouse, Rabbit, Dog, Cat, Tortoise, Fowl, and Man. I used three kinds of aniline colors, viz., Cyanine, for the blue staining, and Erothrosine and Chromotrop for the red. These anilines do not appear in the list of colors used by Auerbach, but they give the characteristic stains for the sperm and the ovum as described by him.

In all of the animals mentioned, the nuclear contents of the well developed spermatozoon is eminently cyanophilous, that is, it takes cyanine in preference to chromotrop or erythrosine, and the nuclear contents of the ovarian ovum, particularly the nucleolus, is erythrophilous, that is, it takes either erythrosine or chromotrop in preference to cyanine.

It is difficult, however, to tell how much of the contents of the nucleus of the ovarian ovum, before a portion of its chromosome has been removed in the formation of polar globules, is directly comparable with the nuclear contents of a single spermatozoon, and we are therefore in doubt as to how far a color contrast obtained in differential staining of the two sexual cells actually indicates the real nature of the chromosomes contributed by two parents to the body of an embryo. It seems important to bear this point in mind, for, in instituting comparisons between the nucleus of the spermatozoon and of the ovarian ovum, as representative elements of the maternal and the paternal organisms, one is left to infer that the protoplasmic contents of the two are in an analogous stage of development—an inference open to objection. If the germinal vesicle of the well-developed ovarian ovum is to be compared with any structure in the male organism, it ought to be compared with the nucleus of the sperm mother cell or the spermatocyte, and not with that of the spermatozoon.

[1]This department is edited by Dr. E. A. Andrews, Johns Hopkins University.

[2]An abstract of a paper read before the Biological Club, Clark University, Worcester, Mass., March 10, 1892.

As I have already indicated in my previous note on the *Sertoli's cell*,[1] the cyanophilous quality of the spermatozoon nucleus is only the final phase of the varied series of color-reactions, which the sperm-producing cell presents at different stages of its development. The male germinal substance is not always blue in its color reaction. The male germinal substance at the beginning (spermatogonium stage), is not cyanophilous, but its color reaction is violet, due probably to a mixture of blue and red color; while at the next stage (spermatocyte), the color reaction of the chromosome is decidedly *green*, with one or two intensely erythrophilous nucleoli.

The transition of the chromatophilous qualities of the nuclear substance of the male cell from *violet* (spermatogonium), *green* (spermatocyte), *greenish-blue* (spermatide) and *deep blue* (spermatozoon), each new color-reaction corresponding to the morphological change in the sperm-cell, is certainly very instructive as clearly shown in my preparations illustrating mammalian spermatogenesis. The change in the chromatophilous quality of the male cell at different stages of its existence, may be due to corresponding changes in the quality of the protoplasm itself, and the whole phenomena of the successive series of forms of the sperm-cell must be due to the corresponding alteration in the nature of the protoplasmic material: when the male cell assumes its final stage as a well-developed spermatozoon, with its complicated apparatus for locomotion, accompanied, as in many cases, with an accessory apparatus, which facilitates the penetration of the sperm-nucleus into the substance of the ovum (as the head-spine for boring and the recurved hook at its tip, etc.), the quality of the protoplasmic substance has changed so much as to take an entirely different color from that of the ovum, which maintains the typical characteristics of an animal cell. That the ovum and the sperm become differently colored is, then, just what we might expect on *a priori* grounds, knowing the analogous differences mentioned in the history of the spermatozoon alone.

The critical point one is most interested to know is, whether the blue color, which characterized the nucleus of the spermatozoon, still persists or not, after the sperm-cell has entered into the substance of the ovum, and the form of its nucleus has undergone change by becoming spherical again. According to Auerbach's theory of heredity, the blue color must persist. I am not able to say anything definitely on this point, for I have not yet finished my research on this particular subject. I have said enough, however, to show, that the

[1]This Journal for May, 1892, p. 442.

cyanophilous quality of the paternal nucleus is by no means a constant character. It does not appear improbable that, after the sperm-nucleus had become transformed into the male pronucleus, indistinguishable from the female pronucleus in its contour, in its size, in the arrangement and the number of its chromosomes—the points strongly emphasized already by many workers in this field—the quality of the "male" and the "female" substance may no longer be more distinguishable in color reactions than they are in other respects; and that such differences as exist between them may be simply those that differentiate one organism from another of the same species.

We may say then, that the differentiations of the germ cells in the two sexes, which are shown not only in their form and size, but also in their chemical qualities, indicated by differential staining, are the device indicated (to use figurative language) to secure the union of two different individuals, with a special view to effect the transit of the male cell to the ovum and that with the successful union, or the close approximation, of two germ pronuclei, the "sexes" of the pronuclei become lost and they become non-sexual.

Just what determines the sex of the resulting embryo, which starts from this non-sexual stage, is quite another question.

Since, in general, it is the male that deviates most from the original or non-sexual form, the formation of the sperm-cell by a process much more complicated than that of the ovum may find a parallel among the similar facts in the evolution of the so-called "secondary sexual characters." The "primary" sexual structure—the germ-cell—may be said to undergo a series of changes parallel to those that take place in somatic structures. The significance of the complicated process of spermatogenesis when compared with oogenesis lies in the fact that it is part of a general law.

But if the "primary sexual character," a structure taking a direct part in reproduction, pursues in its development a path similar to that of the development of a "secondary sexual character," or structure taking only an indirect part in reproduction, it follows that the distinction between "primary" and "secondary" sexual character is more or less a nominal one.—S. WATASE, Clark University, Worcester, Mass.

Non-Sexual Reproduction in Sponges.[1]—Prof. H. V. Wilson of Chapel Hill, N. C., makes an interesting contribution to the subject of sexual and non-sexual reproduction of animals in a paper upon the

development of certain undescribed silicious sponges, found upon the Massachusetts Coast and in the Bahama Islands.

Though the egg development was studied in a number of sponges it is only the non-sexual development by gemmules that is of special interest in this connection.

In *Esperella fibrexilis* n. sp. of Woods Holl, Mass., the first appearance of the gemmules was traced to certain plump cells in the mesoderm. Such cells collect into groups of varying size: in each group the central ones are rather closely packed while the outer ones arrange themselves in the form of a follicle. Such clusters are the gemmules. Though it is possible that some gemmules may be formed from single cells, most are aggregates of many separate cells and in all growth takes place not only by cell division inside the gemmule, but by the actual fusion of large and small gemmules; so that the ultimate mass is of complex multicellular origin.

When the gemmule is full grown it forms a spherical mass of closely packed cells with faintly marked boundaries and full of yolk. The entire mass now projects into a water-canal, suspended as it were by the stalk-like attachments of the follicle.

In this ripe gemmule a remarkable process of subdivision now takes place. The solid aggregate of cells breaks down into clusters of cells, which are separated by liquid. The division continues until all the cells of the gemmule became separated from one another. Then the outer ones rearrange themselves to form an outer layer covering a central mass of amœboid cells, all connected together by processes, though separated by liquid.

The outer layer becomes ciliated and rich in orange colored pigment. At one pole, however, this change does not take place and at the same pole the inner cells crowd together to form a dense mass in which spicules appear.

In this condition the larva breaks out of its follicle, leaves the sponge and swims about actively in the water.

The gemmule larva thus closely resembles an egg larva in having an outer layer of pigmented, ciliated cells (ectoblast) replaced at the *anterior* pole by a thin layer of cells not pigmented nor ciliated; while the mesenchymatous central mass is dense and has spicules only at this same anterior end.

The larva attaches itself by its anterior end, but obliquely, so as to lie upon its side. Even before this a change extended from the anterior pole over the rest of the larva, the ectoderm becomes gradually

[1]Journal of Morphology, V, 1891.

flat and single. The sponge grows out as a circular disk, later becoming irregular. It is covered by the flat ectodermal membrane and inside contains spicules all through the mesenchymatous substance of the body.

The various canals and cavities of the sponge arise here and there with no arrangement. Later they connect with one another and break through to the surface as oscula and pores. The ciliated chambers are formed in the midst of special clusters of bulky mesoderm cells that divide to make walls about the intercellular space thus bounded. The way in which these special cells form the ciliated chambers varies in different larvæ.

In discussing the remarkable gemmule development the author points out that, if it has any value as indicating the past history of sponges, it is evidence of the former existence of a solid ancestor as maintained by Metschnikoff. It is mainly, however, the resemblance of this non-sexual larva to the egg larva of other sponges that is to be emphasized. Pointing out the resemblance in the formation of "germ layers" and the peculiarites of the anterior pole and changes of the "ectoderm," Dr. Wilson then accentuates the comparison by applying certain views of Prof. Weismann. As any mesenchyme cell may, apparently, produce an ovum so any mesenchyme cell may unite with others to make a gemmule. The gemmule cell has, alone, but little histogenetic plasma, but an aggregate can form a larva. The gemmule cell is thus a germ-cell differing from the ovum in having its germ plasma not partly converted into ovogenetic plasma. Some such likeness between the egg cell and the gemmule cell is necessary to explain the observed resemblances between the egg larva and the gemmule larva.

ARCHAEOLOGY AND ETHNOLOGY.[1]

MAN AND THE MYLODON.

Their Possible Contemporaneous Existence in the Mississippi Valley.

In one of the alcoves of the Museum of the Academy of Natural Sciences, Philadelphia is to be seen a considerable number of fossil bones of extinct animals belonging to the pleistocene period. In color, texture and general outward appearance they have a remarkable sim-

[1]This department is edited by Dr. Thomas Wilson, of the Smithsonian Institution.

ilarity as though they had belonged together. They are well preserved, firm in texture, and of a dark chocolate-brown color which has been attributed to ferruginous infiltration. They consist of a nearly entire skeleton of *Megalonyx jeffersoni*, teeth of the *Megalonyx dissimilis* and the *Ereptodon priscus*, bones of the *Mylodon harlani*, bones and teeth of the *Mastodon americanus*, and teeth of *Equus major* and *Bison latifrons*. Along with them is the os innominatum of a human subject. The question affecting the antiquity of man is whether these subjects, the bones of which were found together, were, when alive, contemporaneous, and whether the evidence of age in one is evidence of age in the other. They were all presented to the Academy by Dr. Dickeson at the meeting in October, 1846; description thereof is to be found in the Proceedings of the Society for that year, vol. iii, p. 106. Dr. Dickeson reported at that time that they were discovered by him in a single deposit at the foot of the bluff in the vicinity of Natchez, Mississippi. He says "The stratum that contained these organic remains is a tenacious blue clay that underlies the diluvial drift east of Natchez, and which diluvial deposit abounds in bones and teeth of the *Mastodon giganteum*; that they could not have drifted into the position in which they were found is manifest from several facts, first, that the plateau of blue clay is not appreciably acted on by those causes that produce ravines in the superincumbent diluvium; second, that the human bone was found at least two feet below the three associated skeletons of the *Megalonyx*, all of which, judging from the position or proximity of their several parts, had been quietly deposited in this locality independent of any active current or any other displacing powers; and lastly, because there is no mixture of diluvial drift with the blue clay, which latter retains its homogenous character equally in the higher parts which furnished the extinct quadrupeds and in its lower part which contained the remains of man." These specimens thus found associated were made the subject of investigation by Sir Charles Lyell, and afterwards by Dr. Joseph Leidy, the latter having published a memoir with illustrations of the human bone in the Transactions of the Wagner Free Institute of Science, vol. ii, p. 9. He says "It differs in no respect from an ordinary average specimen of the corresponding recent bone of man."

Dr. Leidy says Lyell expressed the opinion that, although the human bones may have been contemporaneous with those of the extinct animals with which it has been found, he thought it more probable that it had fallen from one of the Indian graves and had become mingled with the older fossils which were dislodged from the deeper part of

the cliff, and Dr. Leidy adds: "In the wear of the cliff the upper portion, with the Indian graves and human bones, would be likely to fall first, and the deeper portions with the older fossils, subsequently on the latter."

Although Dr. Leidy testifies to the general similarity of appearance of the human with the other bones, it does not seem to have occurred to him to have them analyzed and compared. Remembering the story told by the analysis and consequent comparison of the Caleveras skull with that of the rhinoceros skull found in a formation corresponding in age, though in a different locality; and of the fact apparent therefrom that the Caleveras skull was in an equally advanced stage of fossilization as the rhinoceros skull, I deemed it wise to make an examination and test by analysis. To this end I applied to Prof. Angelo Heilprin, and through him to the authorities of the Philadelphia Academy, so a few months since specimens certified by Prof. Heilprin have been taken, one from the bone of the man and the other from one of the bones of the mylodon, choosing those which for size, texture and general appearance bore the greatest likeness one to the other. These were submitted by me to Prof. F. W. Clarke, Chemist of the United States Geological Survey, on duty at the National Museum, who has just returned the result of his analysis, which is here published for the first time.

TWO FOSSIL BONES.

	Man. Per cent.	*Mylodon.* Per cent.
Loss at 100°C	4.55	6.77
Loss on ignition	16.54	21.18
Silica ($Si\ O_2$)	22.59	3.71
Phosphoric acid ($P_2\ O_5$)	17.39	23.24
Alumina ($Al_2\ O_3$)	3.21	4.02
Iron protoxide ($Fe\ O$)	5.65	4.44
Maganese protoxide ($Mn\ O$)	1.65	3.40
Lime ($Ca\ O$)	25.88	30.48
Magnesia ($Mg\ O$)	0.95	0.78
	98.41	97.02

Alkalies, carbonic acid and fluorine were not looked for, owing to the small amount of available material, hence the low summation.

The importance of this analysis will be apparent at a glance. The human bone is in a higher state of fossilization than is that of the

Mylodon. It has less lime and more silica. In their other chemical constituents they are without any great difference. Of lime the bone of the Mylodon has 30.48%, while that of man has but 25.88%. Of silica the Mylodon has 3.71%, while man has 22.59%. I am well aware of the ordinary uncertainty of this test when applied to specimens from different localities and subjected to different conditions; but in the present case no such differences exist. The bones were all encased in the same stratum of blue clay, and were subjected practically to the same conditions and surroundings. As one swallow does not make a summer so the discovery of one specimen does not prove the antiquity of man; but it is to be remarked that upon each discovery and in almost every investigation the evidence found points towards higher antiquity of man and tends to show the occupation of the earth by prehistoric man to be more and more extensive. This discovery is simply a fact to be put down to the credit of the high antiquity of man. We should proceed in the same direction to discover other evidences, to investigate the value of those already found; and as they accumulate, each one or all together should be given their fair value, in the endeavor to arrive at a truthful conclusion independent of *a priori* theory or preconceived idea.

MICROSCOPY.[1]

Methods of Decalcification. Continued.—*V. von Ebener's Hydrochloric Acid and Sodium Chloride Method.*[2]—To avoid the swelling caused by hydrochloric acid the author gives the following formula:

Hydrochloric acid	2.5 parts.
Alcohol	500. "
Sodium chloride	2.5 "
Distilled water	100. "

The fixed and hardened tissue is placed in this solution, which is daily strengthened by the addition of a small quantity of acid; when decalcified the preparations are washed in a half saturated aqueous solution of sodium chloride; when the solution shows an acid reaction it is neutralized by the addition of ammonia; this is repeated until the acid is entirely removed.

[1]Edited by C. O. Whitman, Clark University, Worcester, Mass.

[2]Wien. Sitzungsber., 1875, Zeit. f. wiss. Mikros., Bd. viii, p. 6, 1891.

Waldeyer's Hydrochloric Acid and Palladium Chloride Method.[1]—Small pieces of fixed and hardened tissue are decalcified in a solution consisting of:

Hydrochloric acid....................................	10. parts.
Palladium chloride.....	1. "
Distilled water..	1000. "

If not softened at the end of 24 hours the solution should be renewed; when decalcified the objects are washed in 70% alcohol until the acid is removed.

Bone Cells.—*Chiarugi's Method.*[2]—Small pieces of fresh bone are decalcified in picro-nitric acid prepared by adding 2 c.c. nitric acid to 100 c.c. saturated aqueous solution of picric acid; this solution is then diluted with two volumes of distilled water; when decalcified the tissue is washed in alcohol of increasing strengths. The sections are stained for a few minutes in a 1% eosine solution and decolorized in a 3% solution of potassium hydrate. The ground substance becomes colorless, while the bone cells and their processes are deeply stained. To fix the eosine the sections are washed and mounted in a 1% alum solution.

Fibres of Sharpey.—*Kölliker's Method.*[3]—The decalcified tissue is treated with concentrated acetic acid until transparent, when it is transferred to a saturated solution of indigo-carmine for a minute and then washed in distilled water; mount in glycerine or Canada balsam. The fibres of Sharpey are red, the remaining bone substance blue. Lithium carmine and safranin also differentiate the fibres.

Another method[4] employed is to heat the section in a crucible. The calcified fibres are shown with remarkable clearness.

Bone Medulla.—*Bizzozero's Method.*[5]—The author, after trying many methods, finds the following most useful in studying the elements

[1]Arch. f. mikro. Anat., Bd. xi, 1875; Stricker's Manual of Histology, 1872, p. 1052.

[2]Bollet. della Soc. trai cult. della Scienza Med. Siena. fasc. viii, 1886; Zeit. f. wiss. Mikros., Bd. iv, p. 490, 1888.

[3]Zeit. f. wiss. Zool., Bd. xliv, p. 644, 1886.

[4]Zeit. f. wiss. Mikros., Bd. iv, p. 87, 1888.

[5]Atti della R. Acad. della scienze di Torino, vol. xxv, p. 156; Arch. f. mikro. Anat., Bd. xxxv, p. 424, 1890; Zeit. f. wiss. Mikros., Bd. vii, p. 513, 1890.

of the medulla. The fresh tissue obtained by splitting the bone is fixed in Flemming's fluid, or still better, in a saturated solution of mercuric chloride in a 1% salt solution. After 2–3 hours the object is transferred to a mixture of the 1% salt solution and 90% alcohol, where it remains for 48 hours. It is then hardened in alcohol. The best results were obtained by staining the sections in hæmatoxylin or an aqueous solution of safranin and decolorizing with picric acid-alcohol. The amount of picric acid added to the alcohol is a matter of experiment. The proportions must be such that the protoplasm of the leucocytes remains uncolored when the nuclei of the red blood corpuscles are yellow. Müller's fluid fixes the red blood corpuscles better than sublimate. The sections are stained for a minute in a few c.c.'s of water to which have been added several drops of Ehrlich-Biondi's solution, then passed through the grades of alcohol, cleared in clove oil and mounted. The eosinophilous granules of the leucocytes are red or rose ; the erythroblasts and blood corpuscles dark orange-red.

Löwit's Method.[1]—In the study of leucoblasts and erythroblasts Löwit employs the following method: Small pieces of bone medulla are fixed in a 1%–2% solution of platinum chloride in which they remain from 12–48 hours, then washed in running water for 24 hours, run through the grades of alcohol and imbedded in paraffine. The sections are stained for 2–4 minutes in an alcoholic solution of safranin, thoroughly washed in alcohol and treated with iodine-picric acid, which is prepared as follows: To a watch glass of 1% alcoholic solution of picric acid a drop or two of officinal iodine tincture is added. The sections remain in this solution for 10–30 seconds, when they are washed in alcohol, cleared in clove oil and mounted. Connective tissue and leucoblasts are yellow, erythroblasts red. If the sections are left too long in the iodine-picric acid or the solution is too strong all the elements appear a brownish-red. A little experience will soon enable one to obtain the desired results.

Demarbaix's Method.[2]—In studying the division and degeneration of the giant cells of the marrow employs the following method: The tissue is fixed for 24 hours in a mixture of

1% Chromic acid..................	14 parts.
Glacial acetic acid..................................	1 part.
Distilled water.........	18 parts.

[1]Arch. f. mikro. Anat., Bd. xxxviii, p. 533, 1891.

[2]La Cellule T. v, p. 27, 1889; Zeit. f. wiss. Mikros., Bd. vii, p. 73. 1890.

It is then washed for 24 hours in water, passed through the grades of alcohol and imbedded in paraffine. The sections are stained with safranin according to the method of Babes,[1] viz.: To a 2% aqueous solution of aniline oil is added an excess of safranin. Stain in a thermostat at 50° C., decolorize for an instant in acid alcohol, mount in balsam.

SCIENTIFIC NEWS.

Recent Deaths.—Dr. Andrew Crombie Ramsay, the geologist, Dec. 9, 1891, at the age of 76 years. He was largely self-taught and was appointed Professor of Geology in University College, London, in 1848. In 1851 he was chosen to the same chair in the newly formed School of Mines. He was said to be without a superior as a lecturer. Dr. J. F. Williams, Professor of Mineralogy and Geology in Cornell University, was but 29 years old at the time of his death. He was a graduate of the Renssalaer Polytechnic Institute and received his doctor's degree from the University of Göttingen. Before going to Cornell he was connected with the Pratt Institute, at Brooklyn, and with the Arkansas Geological Survey. Baron Achille de Zigno, the well-known geologist, in Padua, January 18, 1892. Carl Freiherr von Camerlander, Praktikant in the Museum of the Geological Reichsanstalt, in Vienna, Jan. 17, 1892. J. W. Ewald, geologist, in Berlin, in December, 1891, aged 81. George Haggar, some forty years ago a collector of Lepidoptera, at Ore, England, Jan. 10, 1892, aged 75. Francis Archer, conchologist and entomologist, at Liverpool, March 1, 1892, aged 52.

Tufts College, at College Hill, Mass., has established a chair of biology, and Dr. J. S. Kingsley has been appointed to fill the position. Prof. J. P. Marshall retains the geology and mineralogy.

In a recent popular work on evolution is a "glossary" of scientific terms in which the following typographical error occurs: "Zoea, the larva of decayed (? decapod) crustaceans."

[1]Zeit. f. wiss. Mikro., iv, p. 470, 1887.

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Boston, July, 26, 1892. *Secretary.*

992-S.

THE

AMERICAN NATURALIST

VOL. XXVI. August, 1892. 308

WHY THE MOCKING BIRDS LEFT NEW JERSEY—A GEOLOGICAL REASON.[1]

BY SAMUEL LOCKWOOD, PH. D.

Is it not "past the infinite of thought?" Even though expressed in numbers, who has a mental grasp of the stellar distances? And equally inadequate is the time conception of any working æon taken by nature in sculpturing the features of our Mother Earth. Still, though we may do no better than conjecture the time of any special fashioning, so dim is the distance, yet the geologic record makes clear the fact that the sea coast of New Jersey formerly extended very much farther into the Atlantic than it does to-day. In taking soundings off the coast the lead will drop suddenly into deep gorges in the ocean bed, thus revealing, as it were, an oceanic valley nearly parallel to the coast line. Though about a hundred miles south-east of the present mouth of the Hudson, this seems to denote the ancient outlet of the river into the sea. All this is in accord with the facts known concerning the subsidence of the New Jersey coast. Even when Hudson saw them, the Highlands of Navesink were somewhat higher than now, hence with the Squan Highlands, the first land sighted by homing vessels, were visible further out at sea. These

[1]Read at the Ninth Congress of the American Ornithologists' Union in New York, Nov. 16, 1891.

Mo. Bot. Garden,
1893

Monmouth Highlands mark the extreme south and north points of the county coast line; for the rest, the New Jersey shore is mainly a sandy flat, which formerly was thickly fringed with evergreens, much of it being cedar and cypress, though the prominences mentioned were densely wooded with deciduous trees.

In the southern part of the State exists a curious industry—the mining for cedar—exhuming from their swampy burials the white cedars, *Cupressus thyoides.* Some of these noble trees much exceeded three feet in diameter, with the timber perfectly sound. "The lay" of these uprooted trees indicates the devastation probably of extraordinary cyclones occurring at immense intervals of time, thus leveling one forest upon another that had been thrown long before. Even the cedars standing there to-day are a growth over their long buried ancestors. Of two at least of these buried forests beneath the present growth the evidence is indisputable. Counting the season rings some of these exhumed trees must have taken 1500 and possibly 2000 years to grow. But I am not especially concerned with the question of time—it is the fact of subsidence.

And this action is still in progress. Nay, some notable instances there are which present phenomena appealing to our eyes. On the south side of Raritan Bay, or rather Keyport Bay, which is simply an indenture of Raritan, is a clay bluff that in my own recollection has lost much in altitude. Standing on this eminence some ten or twelve feet higher than the line of high tide, I have seen at times of very low tide, in the distance, stumps of trees, in the same position in which they were left by the woodman's axe when he cut down the forest or grove which grew on that bluff when it reached much farther seaward than now. And perhaps even stranger still, a little north of this, and something nearer the shore, I once saw a great number of broken bricks and a well-curb, the remains, as I learned, of a brick yard, which, like the ancient bluff, had also gone to sea. But I will leave this for a moment.

During a residence of many years at Keyport, N. J., which is not more than two miles from the bluff, I had cherished a little grove of native saplings. They were all seedlings and self-planted. There were scrub oaks, pines, persimmons and a group of bilsteds, or gum trees.

The last attained a considerable height, and all together made a dense covert, in which I took great delight. My pleasure was enhanced by its being a resort for robins, catbirds and some smaller birds. I had thus some good bird music, especially mornings and evenings. It was a summer eve in 1882 when a *Mimus polyglottus* took possession of my cherished grove and opened with a budget of bird music which astonished me. His répertoire was so voluminous and of such variety; indeed, it was a mélange of bird song. The voice was ringing and clear with a quality which I can only call golden. The performance was certainly snatchy, but so rollicking, rapid and impromptu like. The strange thing appeared to me a phenomenon—an avian improvisatoire gone stark mad. Such a bubbling stream of ornithic song—such reckless impetuosity, such phonic exuberance, such imperious audacity of utterance—this defiant monopolist of bird music held me enthralled. It was the first time I had ever heard a wild mocker in the woods. The wonderful creature regaled me in the same grove for six consecutive evenings, then was heard no more. The impression was made on me that my robins and catbirds were also profoundly affected, for on each evening when this grand mæstro sang they observed that respectful silence which is the homage due to superiority.

This incident set me upon inquiry. I found an old man who was born in the last century—a native who had spent his entire life near the bluffs already mentioned. In the parlance of the day "we interviewed" him; hence the dialogue as nearly as can be must be reported.

"How long have you lived in these parts?"

"All my life. Leastwise was never away long at a time."

"Did you ever know of any mocking birds about here?"

"Not of late years, but plenty of 'em when I was a lad.

Many's the time I've gone nesting for them in the cedars that used to be yonder."

"What do you mean by the cedars that used to be yonder?"

"On the bluffs just over there (pointing to the Bay). Sixty year ago that bank was a good deal higher than now, and reached a sight further into the Bay, though the tide comes up just as close as it ever did. But there's a mighty big change there. There used to be a thick forest of red cedar on the bluff, and the mockers, a plenty of them, built there every summer, and there was no trouble in finding a few nests. But there's not been a single cedar there for many years—just how long I disremember. You see the bluff got going to sea so fast they had to cut the cedars to save them. You can see the stumps yet at almost any neap tide. It 'most beats belief that the bluffs ever reached so far as them stumps. Why in my time a pretty good farm has gone off to sea. There used to be a brick yard—that has gone off too. It lay a little north of them cedars, and something can be seen of it when the tide suits. Old Auntie Willets, now dead and gone, used to milk the cows along side of what we called the black rock. That's gone too, and I should think it has sunk considerable, for it's little more than the top of it that one can see at neap tide."

I was surprised at the amount of geology I was abstracting from my informant, and felt that he was getting away from the subject in hand, so I asked: "Have you seen any mocking birds in these parts of late years?"

"Not one in many years as I can remember. The woods don't seem to favor them now. In the time of the cedars they were plenty."

To the old man the word "subsidence" incautiously used by me had no meaning. He had a reason of his own. "Naturally the sea was uprising, sort of overflow on the land. Was it not all the time receiving the waters of all the rivers in the world without any let-up whatever?"

It was some thirty years ago, perhaps more, when I accompanied the late Prof. George H. Cook, the State Geologist, in an inspection of the entire south side of Raritan Bay, my

recollection is that the Professor estimated the present subsiding as proceeding at the rate of a vertical half inch in a year, and the Doctor had gathered other very interesting data, such as the change of level of tide-water mills. The rate stated is certainly enormous when compared with the time taken to produce the subsidence of the cedar swamps or mines.

The cypress and the cedar, also the arbor-vitæ, but especially the former, loved the sandy levels of the New Jersey coast. But with subsidence and the woodman's axe very little of these sheltering copses of evergreens is left. Forty years ago an occasional pair of mockers has been known, even in the central part of the State by a stream in a deciduous tkicket, with catbriers interlaced. But the bird even then was rare—and is much rarer now. The hospitable shelters and food resources on the shores are gone, and the mocker has virtually left also. The bird has yielded to the fiat of geological change—the inevitable law to which the flora and the fauna of the earth must bow.

Our position is not that these birds can no longer live in New Jersey, but that the situation is less inviting than formerly; in a word, the bird life is harder. As to shelter and food, the old summer home has become less hospitable. There is a third factor beyond reach in this discussion, that of climate. True, we do know something of this as caused by the denuding of the land of its native forests; but we know nothing of that climate when the shores of the State, far-reaching into the sea, hugged more closely the thermal Gulf-stream. It will appear too, that we have taken no note of the effect of contact with civilization, which in the main is less conservative than even geologic change.

In the dialectics the principle is accepted that the exception may establish the rule. This, though often true in the mental realm, is but rarely so in that of the physical. Hence it is not only interesting but quite remarkable to find our position fortified by a geological exception, almost on the spot which has come directly under our review. Raritan Bay is in part bounded by the little peninsula of Sandy Hook. While the main is suffering from subsidence of the land and denudation

of the forests, Sandy Hook is increasing in both these respects. It is lengthening out without narrowing, and maintaining, protected from the axe, a dense and increasing growth—a fine virgin forestage on its sandy beaches of the very tree flora which has so nearly departed from the flats of the State. We have there also at least nearly the climate which with such shelter prevailed over the mainland, where now is the inhospitable bleakness of the naked beach. Æolic action is keeping up an undertow on the coast line, carrying to the Hook and depositing a part of the very material which subsidence and tidal wash is stealing from the shore southward. And so dense is the growth of cedars, with grand outliers of the crimson berried hollys, that not only are these evergreen groves opulent in food, but also practically impervious to the winter winds. Here are rookeries of crows, which almost blacken the air as they return in the evening from their daily foraging. Here, too, are robins by "the thousands," both summer and winter. And here too in this bird paradise has our *Mimus polyglottus*, summer and winter, as far back as the memory of man goeth, found a hospitable home. With warm housing and a generous board a fig for "the sunny South." With desire satisfied the migratory instinct has died out.

Let me close with a little avian episode. At Sandy Hook is a military establishment for cannon practice and testing the new monster ordnance and projectiles. So bold and familiar are these birds that they seem not to mind the flying and exploding shells. The wife of the superintendent, having found a nest of mocking birds, made it frequent visits, to which the parent birds seemed not to object. The lady's interest in her find increased, and when the young became fledglings she removed them from the nest to a cage and brought them up as pets. To her surprise the old birds kept near the young ones, becoming regular visitors, especially at feeding time, thus sharing with the young the lady's bounty. Their tameness became remarkable. The fully feathered young were allowed their freedom, and parents and offspring would betake themselves to the grove, but would return on call of their benefactress at feeding time, when would ensue a scene of interest

often witnessed by the officers. At the summons—"Mockie, Mockie, Mockie," the entire family would come and alight, even upon the lady, accepting her hospitality and permitting her caresses. All this was kept up through the entire winter. In March, 1888, occurred the great blizzard. This fearful snow storm invaded the retreat of the birds, interpenetrating the hitherto impenetrable asylum. So soon as the storm had subsided the lady went to the woods to look up her little avian friends. Her customary gentle call resounded through the dense grove. But no response came from the mockies. At last her pets were found on the white ground—dead! Thus, too, it befell many others in the colony, which was then on the increase. Happily a remnant survived the storm, so that still, representatively, *Mimus polyglottus* occupies this little elysium so typical of the once grander New Jersey home of his ancestors.

HEREDITY AND THE GERM-CELLS.

By Henry Fairfield Osborn.

The Cartwright Lectures for 1892, III.

(*Continued from Page 567, Vol. XXVI.*)

According to the general law[1] the germ-cell is considered as matter potentially alive and having within itself the tendency to assume a definite living form in course of individual development. The nucleus must be extraordinarily complex, for it contains within itself not only the tendencies of the present type, but of past types far distant. The supposition of a vast number of germs of structure is required by the phenomena of heredity; Nägeli has demonstrated that even in so minute a space as $\frac{1}{1000}$ cub. millimetre, 400,000,000 micellæ must be present.

The study of heredity will ultimately centre around the structure and functions of the germ-cells. The precise researches of Galton show that the external facts of heredity, questions of averages and of probabilities, of paternal and maternal contributions to the offspring, are capable of being reduced to an exact science in which mathematical calculations will enable us to forecast the characteristics of the coming generation.

There will still remain, however, a large residuum of facts which will present themselves to a mathematician like Galton as chance or inexact, such as the physiological conditions of reversion; the causes of prepotency, by which the maternal or the paternal characteristics prevail in parts or in the entire structure of the offspring; the material basis of latent heritage upon which reversion depends, and which compels us to hypothecate either an unused hereditary substance or a return to an older disposition of the forces in this substance; the nature and determination of sex. These apparently chance

[1]See Huxley, Article Evolution, Enc. Britannica, p. 746.

phenomena must also be due to certain fixed laws, and by far the most promising routes to discovery have already been taken by Van Beneden, the Hertwig brothers, Boveri, Maupas, and others.

They have attacked the problem of the relation of the germ-cells to heredity on every side, and by the most ingenious and novel methods, which are familiar enough in various branches of gross anatomical and physiological research, but seem almost out of the limits of application to minute microscopic objects. For example, the Hertwig brothers have ascertained the influences of various solutions of morphine and other drugs, of the alcohols, and of various degrees of temperature upon the ovum and spermatozoon during the conjugation

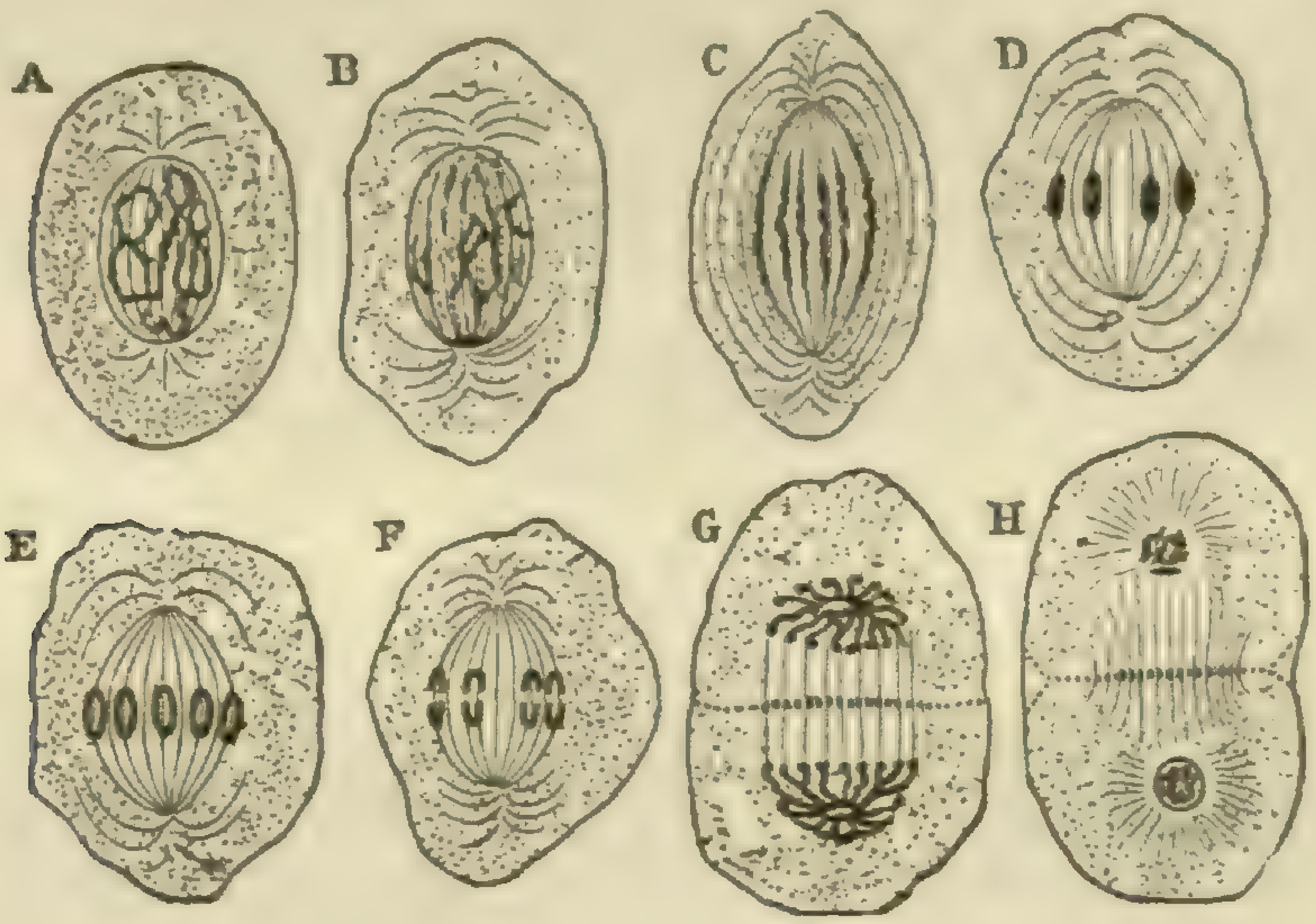

FIG. 7.—TYPICAL CELL DIVISION, SHOWING THE DISTRIBUTION OF CHROMATIN. (From Parker, after Carnoy) A-C, Arrangement of the chromatin in threads ; D-E, Formation of the chromatin rods and loops ; F, Splitting of the loops ; G-H, Retraction of the chromatin into the two daughter-cells.

period, with results which are highly suggestive of the causes of congenital malformations, anomalies, and double births. The Hertwigs and Boveri have succeeded in robbing ova of their nuclei, and watching the results of the subsequent entrance of spermatozoa. In order to further test the relations of the nucleus to the remainder of the cell, Verworn has experimented along the same line with extirpations of every kind from the single cells of Infusoria. Of equal novelty are

the recent studies of Maupas upon the multiplication and conjugation of the Infusoria, giving us a host of new ideas as to the cycle of life, the meaning of sex, and the origin of the sexual relation.

In all this research and in the future outlook there are two main questions:

1. *What is the hereditary substance?* What is the material basis of heredity, which spreads from the fertilized ovum to every cell in the body, conveying its ancestral characteristics? Is there any substance corresponding to the hypothetical idioplasm of Nägeli?

2. *What are its regulating and distributing forces?* How is the hereditary substance divided and distributed? How far is it active or passive?

I may say at the outset that the idioplasm of Nägeli, a purely ideal element of protoplasm which he conceived of as permeating all the tissues of the body as the vehicle of heredity, has been apparently materialized in the *chromatin* or highly coloring materials in the centre of the nucleus. This rests upon the demonstration by Van Beneden and others that chromatin is found not only in all active cells, but is a conspicuous element in both the ovum and spermatozoon during all the phenomena attending conjugation.

Secondly, that while the chromatin is apparently passive, it is played upon by forces resident in the clear surrounding protoplasm of the nucleus, but chiefly by the extra nuclear *archoplasm*, which seems to constitute the dynamic and mechanical factor in each cell. This, unlike the chromatin, only comes into view when there is unusual activity, as during cell-division, and is not evident (with our present histological technique, at least), when the cell is arrested by reagents in any of the ordinary stages of metabolism.

The Distribution of Hereditary Substance.—I may first review some of the well-known phenomena attending the distribution of the chromatin substance to the tissues.

I have borrowed from Parker figures by Carnoy to illustrate the resting and active stages of the cell, and from Watase, a

Japanese student of Clark University, figures representing the high differentiation of the cell-contents during division (figs. 8, 9). They bring out the active and passive elements of the typical cell.

The phenomena of karyokinesis which attend the division and distribution of the hereditary substance throughout the whole course of embryonic and adult development are well illustrated in Carnoy's figures (fig. 7). First we have the qui-

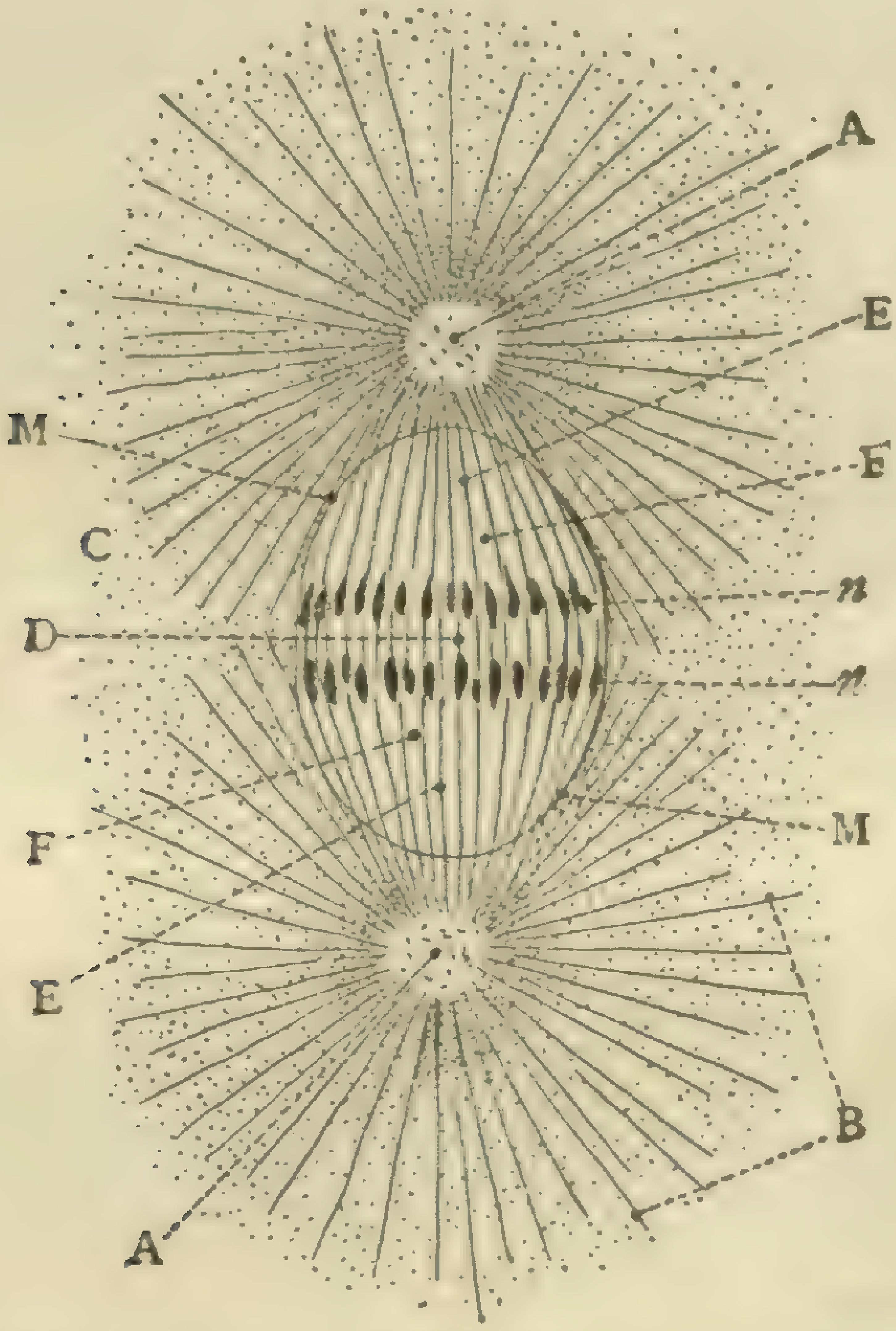

FIG. 8.—BEFORE DIVISION. DIFFERENTIATION OF THE CYTOPLASM AND NUCLEUS DURING CELL DIVISION OF A SQUID EMBRYO, LOLIGO. (After Watase.) M, The nuclear membrane; F, Achromatin or nucleoplasm; C, Cytoplasm, or protoplasm outside of the nucleus; A-A, The two centrosomes of archoplasm, B, Extra-nuclear archoplasmic filaments, E, Intra-nuclear archoplasmic filaments attached to *n*, *n'*, the chromatin rods.

escent period, in which the chromatin presents the appearance of a coiled, tangled thread; surrounding this is the clear nucleoplasm (or achromatin) bounded by the nuclear membrane; the extra-nuclear substance, or cytoplasm, is apparently undifferentiated. As soon as cell division sets in, however, radiating lines are seen in the cytoplasm above and below the

nucleus, these are called the archoplasmic filaments by Boveri, since they proceed from what is now believed to be the dynamic element, the archoplasm (fig. 8). As the activity becomes more intense the filaments are seen to diverge from a centre—the archoplasmic *centrosome*—which lies just without the nucleus at either pole; this radial display of cell-forces suggested the term "asters" to Fol, and "spheres attractive" to Van Beneden. The behavior of the chromatin, or hereditary substance, under these archoplasmic forces, is beautifully shown in Carnoy's diagrams (fig. 7). First, the nuclear wall

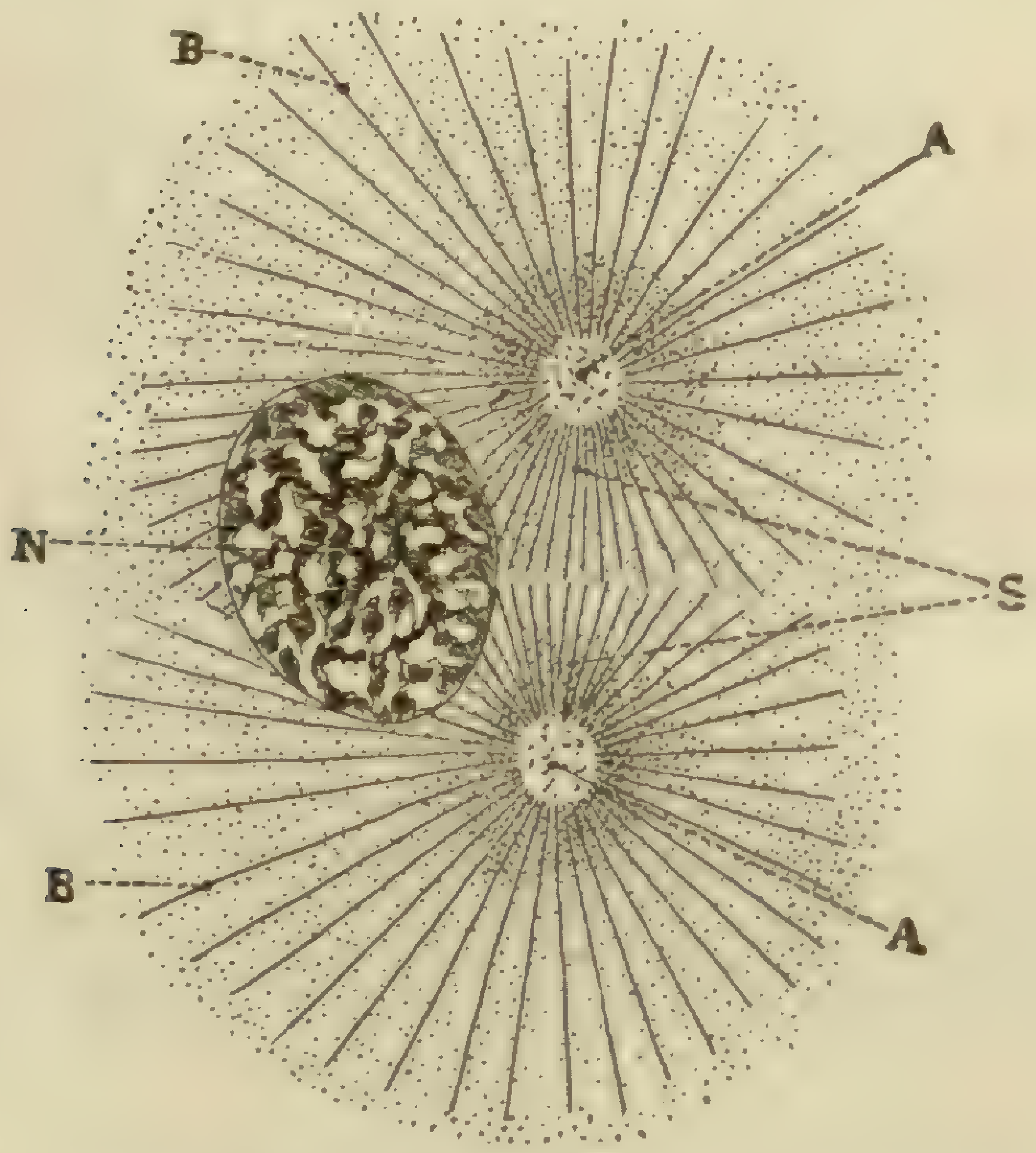

Fig. 9.—After Division. Interior of a Daughter-cell in the Squid. (After Watase.) Division has just taken place and the daughter-nucleus, N, shows the chromatin coil. The daughter centrosome is just forming two new centrosomes, A-A, by direct division.

breaks up, then the chromatin coil unfolds into lines of vertical striation which become thread-like, hence the term mitosis, and then more compact, until finally a number of distinct vertical rods, chromatin rods, or *chromasomes* are formed.

A remarkable and significant fact may be noted here, that the number of chromasomes varies in the cells of different species, and even in the cells of different varieties (as in the thread-worm of the horse—*Ascaris megalocephala*), but is con-

stant in all the cells of the same variety through all stages; thus the same number of chromasomes appears in the first segmentation of the fertilized ovum as in the subsequent cell division in the tissues.

Carnoy next indicates the vertical splitting of each rod into a loop or link preceding the horizontal splitting; thus we may conceive of a thorough redistribution of the chromatin before it passes into the daughter-cells. The split loops are each retracted toward a centrosome, suggesting to some authors a contractile power in the archoplasmic filaments; each chromasome being apparently withdrawn by a single filament. But as the chromasomes separate, the filaments also appear between them, and are variously termed "interzonal," "verbindungs Fäden," "filaments réunissant;" there is, therefore, some difference of opinion as to what the mechanics of the chromasome divisions really are. The chromatin is now retracted into two coiled threads, each the centre of the daughter-nucleus with a single centrosome beside it. But as the line of cleavage is drawn between the two cells (fig. 9), the single centrosome in each cell divides so that each daughter-cell is now complete with its chromatin coil and two archoplasmic centrosomes. This process has been beautifully described by Watase.[2]

It thus appears that both the chromatin and archoplasm are permanent elements of the cell, such as we formerly considered the nucleus; the apparently passive chromatin is divided with great precision by the active archoplasm, then the archoplasm simply splits in two to resume the cleavage function.

Fertilization—The Union of Hereditary Substances.—Before looking at the host of questions which fertilization suggests, let us review a few of the well-known phenomena preparatory to the union of the germ-cells, in order to give greater emphasis to the importance of recent discoveries.

First, the ovum is a single cell, the typical structure of which, with its nucleus and cytoplasm, is generally obscured

[2]See Marine Biological Laboratory Lectures, 1889. Boston: Ginn & Co.

by a quantity of food-material, surrounded by a rather dense cell-wall. The ovum is said to be ripened or "matured" for the reception of the spermatozoon, by the extrusion of two small "polar bodies," containing both chromatin and hyaline protoplasm, and separating off by karyokinetic division. After maturation is complete, a single spermatozoon normally penetrates; then a reaction immediately sets in in the cell-wall of the ovum, which prevents other spermatozoa from entering. The head of the spermatozoon and the nucleus of the ovum now fuse together to form a single nucleus, which obviously contains the hereditary substance of two individuals. This is the starting point of the segmentation or distribution process above described, and it follows that the fertilized ovum at this stage must contain its typical complement of chromatin, archoplasm, etc., for the whole course of growth to the adult.

How shall we connect these phenomena of fertilization with the facts of heredity? The most suggestive enigma in connection with the fertilization process has been *the meaning of the two polar bodies*, especially since Van Beneden demonstrated that they contained chromatin. For twenty-five years speculation has been rife as to why the ovum should extrude a portion of its substance in two small cells; why not in one cell? Why not in a larger number? Thanks to the intense curiosity which these polar bodies have aroused, and to the great variety of explanations which have been offered for them, we have arrived to-day at a solution which links the higher animals with the lower, breaks down the supposed barrier between the sexes, and accords with the main external facts of heredity.

It seems to me best to disregard the order of discovery, and to state the facts in the most direct way. First, a few words as to the speculations upon the meaning of the polar bodies.

The early views of fertilization[3] were naturally based upon the apparent significance of this process in the human species, in which the sexes are sharply distinguished from each other in their entire structure, and the reproductive cells are also

[3]See also the introduction of Weismann's last essay, Amphimixis.

widely differentiated in form, the ovum large and passive, the spermatozoon small and active. The readiest induction was to regard these elements as representing distinct physiological principles, corresponding to the essential sexual characteristics—in short, as male and female cells, the former vitalizing and rejuvenating the latter. Thus one of the earliest definite "polar-body" theories was that the ovum was hermaphrodite, containing both male and female principles, and that it was necessary to get rid of the male substance before the spermatozoon could enter.

As Von Siebold and Leuckart had demonstrated that some ova reproduce parthenogenetically, that is without fertilization by spermatozoa, Weismann turned to such forms for the solution of this problem, and was surprised to find that parthenogetic ova only extrude one polar body; this led him to attach one meaning to the first polar body and another meaning to the second, which he viewed as designed to reduce the hereditary substance in the ovum without regard to sex. Thus both this and the older theory conveyed alike the idea of *reduction*, but with an entirely different supposition as to the nature of the material reduced or eliminated.

Maupas on Conjugation among the Infusoria.[4]—Among the newer researches which throw light upon this old problem those of Maupas are certainly the most brilliant. After a most exact and arduous research, extending over several years, he collected his results in two memoirs, published in 1889 and 1890.

His experiments were first directed upon the laws of direct multiplication by fission, which revealed a complete cycle of life in the single-celled Infusoria and showed that after a long period this mode of reproduction becomes less vigorous, then declines, and finally ceases altogether unless the stock is rejuvenated by conjugation of individuals from different broods. In other words, these broods of minute organisms grow old and die unless they are enabled to fertilize each other by an

[4]Sur la multiplication des Infusoires Ciliés, Archiv de Zoologie expérimentale, Sér. 3, vol. vi, pp. 165–273; Le Rejeunissement Karyogamique chez les Ciliés, vol. vii, pp. 149–517. See also Hartog, Quart. Journ. Microscop. Science, December, 1891.

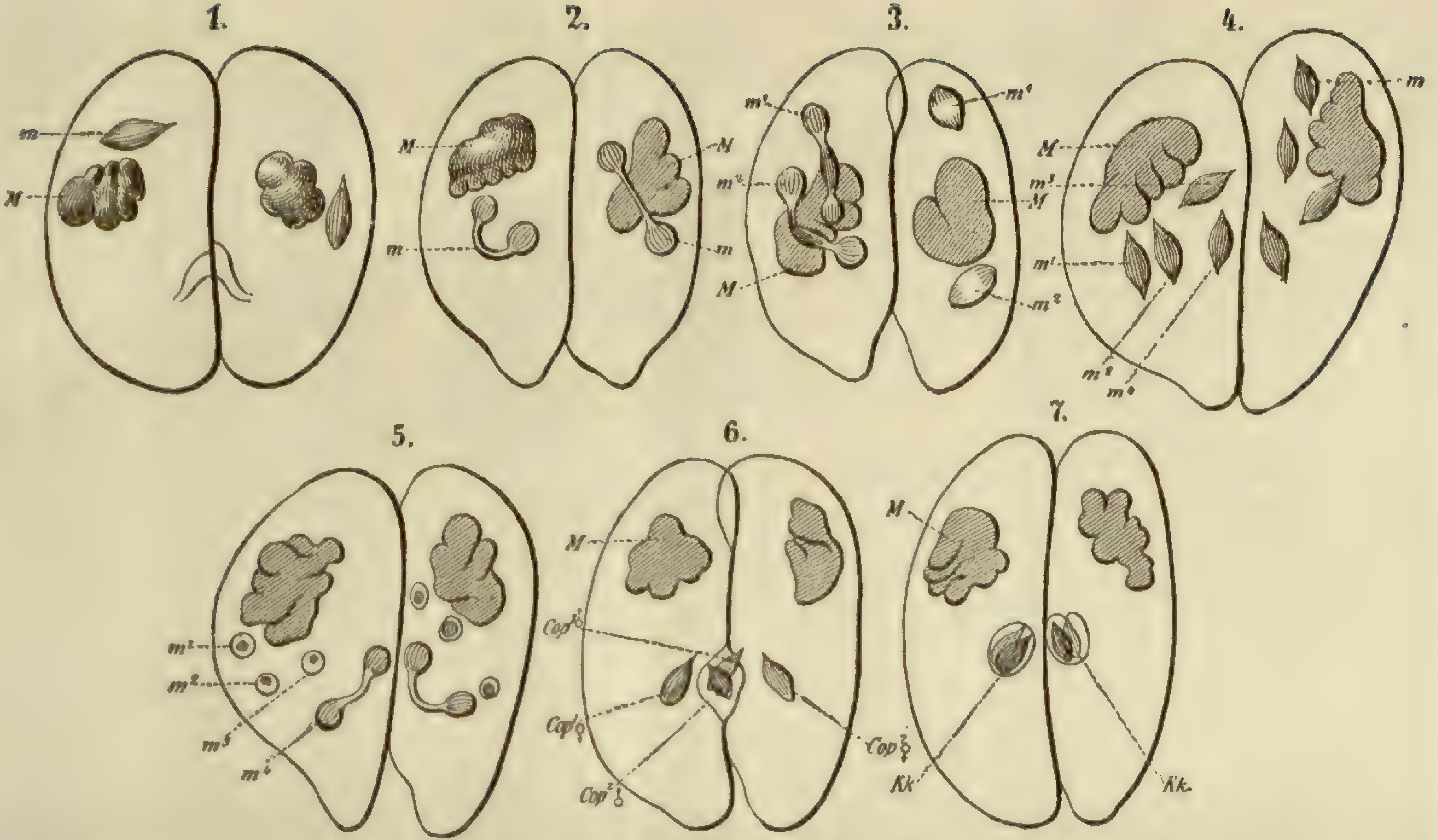

Fig. 10.—The Conjugation of Infusoria. (From Weismann, after Maupas.) 1, Two Infusoria copulating; *M*, meganucleus; *m*, micronucleus; 2-5, Successive divisions of micronuclei; 6, The migration of one of the persisting micronuclei from each infusorian into the other; 7, Union of the interchanged micronuclei.

exchange of hereditary substance altogether analogous to that observed in the higher multicellular organisms.

The cultures were made in a drop of water upon a slide, and feeding was adapted either to the herbivorous or carnivorous habits of the species. Under these conditions it was found that the rate of fission or direct multiplication varied directly with the temperature and food, rising in some species (*Glaucoma scintillans*) to five bipartitions daily. With the optimum of conditions this rate, if sustained for thirty-eight days, would produce from a single individual a mass of protoplasm equivalent to the volume of the sun. This rate is, however, found to be steady for a time, and then the offspring decline into "senescence," in which they appear at times only one-fourth the original size, with reduced buccal wreaths and degenerate nuclear apparatus. This is reached sooner in some species than in others; *Stylonichia pustulata* survives three hundred and sixteen generations or fissions, while *Leucophrys patula* persists to six hundred and sixty generations. Finally, even under the most favorable condition of environment, death ensues.

Not so where conjugation is brought about by mingling the offspring of different broods in the same fluid, as in the natural state. Maupas soon discovered that exhaustion of food would induce conjugation between members of mixed broods. He thus could watch every feature of the conjugation process, and determine all the phases in the cycle of life. These differed, as in the longevity of the species. In *Stylonichia*, for example, "immaturity" extended over the first one hundred bipartitions; "puberty," or the earliest phase favorable to conjugation, set in with the one hundred and thirtieth bipartition; "eugamy," or the most favorable conjugation phase, extended to the one hundred and seventieth; then "senescence" set in, characterized by a sexual hyperæsthesia in which conjugation was void of result or rejuvenescence, owing apparently to the destruction of the essential nuclear apparatus.

Conjugation begins with the approach of two individuals, and adhesion by their oral surfaces. There is no fusion, but an immediate transformation in the cell contents of each indi-

vidual sets in, concluding with an interchange of nuclear substance. In each cell Maupas distinguishes between the (*M*) *meganucleus* (fig. 10, the macronucleus, nucleus, endoplast of authors), which presides over nutrition and growth and divides by constriction, and the (*m*) *micronucleus* (paranucleus, nucleolus, of authors), which presides over the preservation of the species. The latter contains chromatin; it is the seat of rejuvenescence, the basis of heredity, it divides by mitosis, showing all the typical stages of karyokinesis excepting the loss of the cell membrane.

The transformation in each of these copulating cells first affects the centres of hereditary substance, viz., the micronuclei; they divide three times; thus the micronuclear substance is reduced to one-fourth of its original bulk. It is contained in two surviving micronuclei (the others being absorbed or eliminated), one of which migrates into the adjoining cell; the other remains stationary. This migration is followed by a fusion of the migrant and stationary micronuclei; this fusion effects a complete interchange of hereditary substance, after which the two Infusoria separate and enter upon a new life cycle. Meanwhile the meganucleus breaks up and is reconstituted in each fertilized cell.

Maupas gathers from these interesting phenomena additional proof that the chromatin of all cells bears the inherited characteristics and that the cytoplasm and nucleoplasm, or achromatin, is the dynamic agent, because the micronuclei bearing the chromatin are the only structures which are permanent and persistent, all the other structures—nucleoplasm, archoplasm, etc.—being replaced and renewed. The reduction of the chromatin is purely quantitative, the eliminated and fertilizing micronuclei being exactly equivalent; after the chromatin has been quartered the cell becomes incapable of further activity until it is reinforced by chromatin from the copulating cell.

No Distinction Between the Sexes in Heredity.—The three laws which underlie these phenomena are: 1. That fertilization consists in the union of the hereditary substance of two individuals. 2. That before union the hereditary substance in

each is greatly reduced. 3. That there is no line between male and female, the conjugating cells are simply in a similar physiological condition wherein a mingling of hereditary characteristics affords a new lease of life. As Maupas says:

"Les différences appelées sexuelles portent sur des faits et des phénomènes purement accessoires de la fécondation. La fécondation consiste uniquement dans la réunion et la copulation de deux noyaux semblables et équivalents, mais provenus de deux cellules distinctes."

In this conclusion as to the secondary and superficial, rather than fundamental, difference between the two sexes, Maupas simply confirms the views of Strasburger, the botanist, Hensen, R. and O. Hertwig, Weismann, and others, namely, that sex has evolved from the necessity of cell conjugation; that even in the higher forms the cells borne by the two sexes are absolutely neutral so far as sex is concerned, the wide difference of form of the germ-cells is a result of physiological division of labor—the mass and yolk of the ovum having been differentiated to support the early stages of development, while the spermatozoon has dispensed with all these accessories and acquired an active vibratile form for its function of reaching and penetrating the ovum. The evidence of the Infusoria is paralleled among some of the plants, in which conjugation between entirely similar cells is observed.

The causes finally determining sex may come surprisingly late in development, and according to the investigations of Düsing and the experiments of Yung[5] and of Giron are directly related to nutrition. High feeding favors an increase of the percentage of females, while, conversely, low feeding increases the males. In Yung's experiments with tadpoles the following results were obtained:

	Females.	Males.
Normal percentage	57	43
High nutrition	92	8

[5]See Geddes and Thomson: The Evolution of Sex, 1891, also, Düsing: Die Regulierung des Geschlechtsverhältnisses bei d. Vermehrung der Menschen, Tiere und Pflanzen, Jen. Zeit. f. Natur., Bd. 17, 1884.

Geddes expresses this principle in physiological terms of metabolism, that anabolic (constructive) conditions produce females, while katabolic (destructive) conditions produce males.

I think we may now safely eliminate the factor of sex from our calculations upon the problem of heredity, and thus rid ourselves of one of the oldest and most widespread fallacies. We shall thus, in using the terms "paternal" and "maternal" imply merely the distinction between two lines of family descent.

The Theory of Reduction.—This leads us back to the significance of the polar bodies. Van Beneden's discovery that these

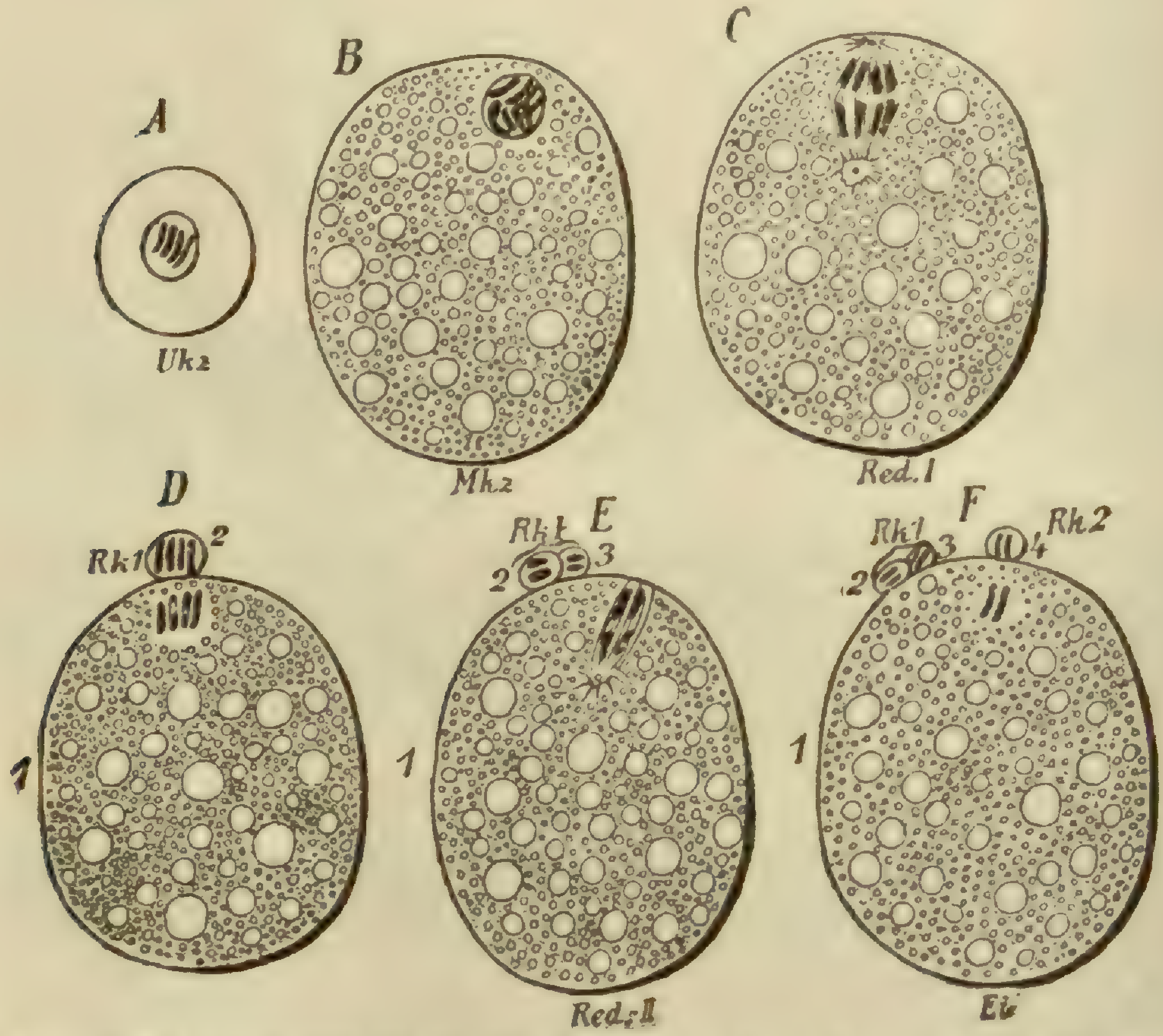

FIG. 11.—THE MATURATION OF OVA, OR FORMATION OF POLAR BODIES IN ASCARIS. (From Weismann after Hertwig.) A, original germ-cell in embryonic germ-layer—4 chromatin rods; B, Ovum mother-cell—8 rods; C-D, First polar body extruded; E, Splitting of first polar body. Ovum still contains 4 rods; F, Second polar body extruded; Ovum mature with 2 rods.

bodies contained chromatin led gradually to the view that they were not fragments of the ova, but represented minute morphologically complete cells. Bütschli showed that they were

given off independently of, and prior to, the contact of the spermatozoon, and, finding in the leeches that the first polar body subdivides to form two bodies, he considered them as formed by true cell division, and containing both nucleoplasm and chromatin. Giard independently reached a similar opinion, assigning an atavistic meaning to the polar cells. Whitman, in 1878, advanced the idea that they represented vestiges of the primitive mode of reproduction by fission, while Mark described them as "abortive ova."

At this point speculation subsided until it was revived by Weismann's attempt to connect these bodies with his theory of heredity,[6] already referred to. The whole history is clearly given in R. Hertwig's masterly memoir upon Ovo and Spermatogenesis in the Nematodes.[7] Taking advantage of Boveri's discoveries in staining technique, and stimulated by Weismann's prediction that spermatozoa would also be found to extrude polar bodies, this author examined all stages in the peculiarly favorable germ-cells of the thread-worm of the horse (*Ascaris megalocephala*).

He made the surprising discovery that ova and spermatozoa are formed in a substantially similar manner by repeated divisions, the single difference being that the last products of division among the sperm-cells are effective spermatozoa, capable of development in fertilization, while the last products of division in the ovary are, first, the true ova, and second, the abortive ova (polar cells) incapable of development. In both ova and spermatozoa the nucleus contains but one-half the chromatin which a typical nucleus contains; in the case of *A. megalocephala* each of the germ-cells contains but two chromasomes while the normal body-cells contain four. The manner in which this maturation of the germ-cells for conjugation is brought about is beautifully shown in these diagrams, taken from Weismann's essay, "Amphimixis." You observe that the number of chromasomes in the primary germ-cells is four (figs. 11 and 12, *A*). Then are formed by subdivision the ovum and sperm "mother-cells," in which the chromatin substance

[6] On the Number of Polar Bodies and their Significance in Heredity. 1887.

[7] Ei- und Samenbildung bei Nematoden, Archi. mikr. Anat., Bd. 26, 1890.

is doubled, so that we observe eight chromasomes. The mother-cells then divide and the chromatin is reduced to four rods, a second division rapidly follows whereby the chromatin is reduced to two rods, or half the original quantity. These last divisions take place by karyokinesis, but, as Hertwig points out, they differ from typical karyokinesis in the fact that the divisions follow so rapidly upon each other that the vesicular

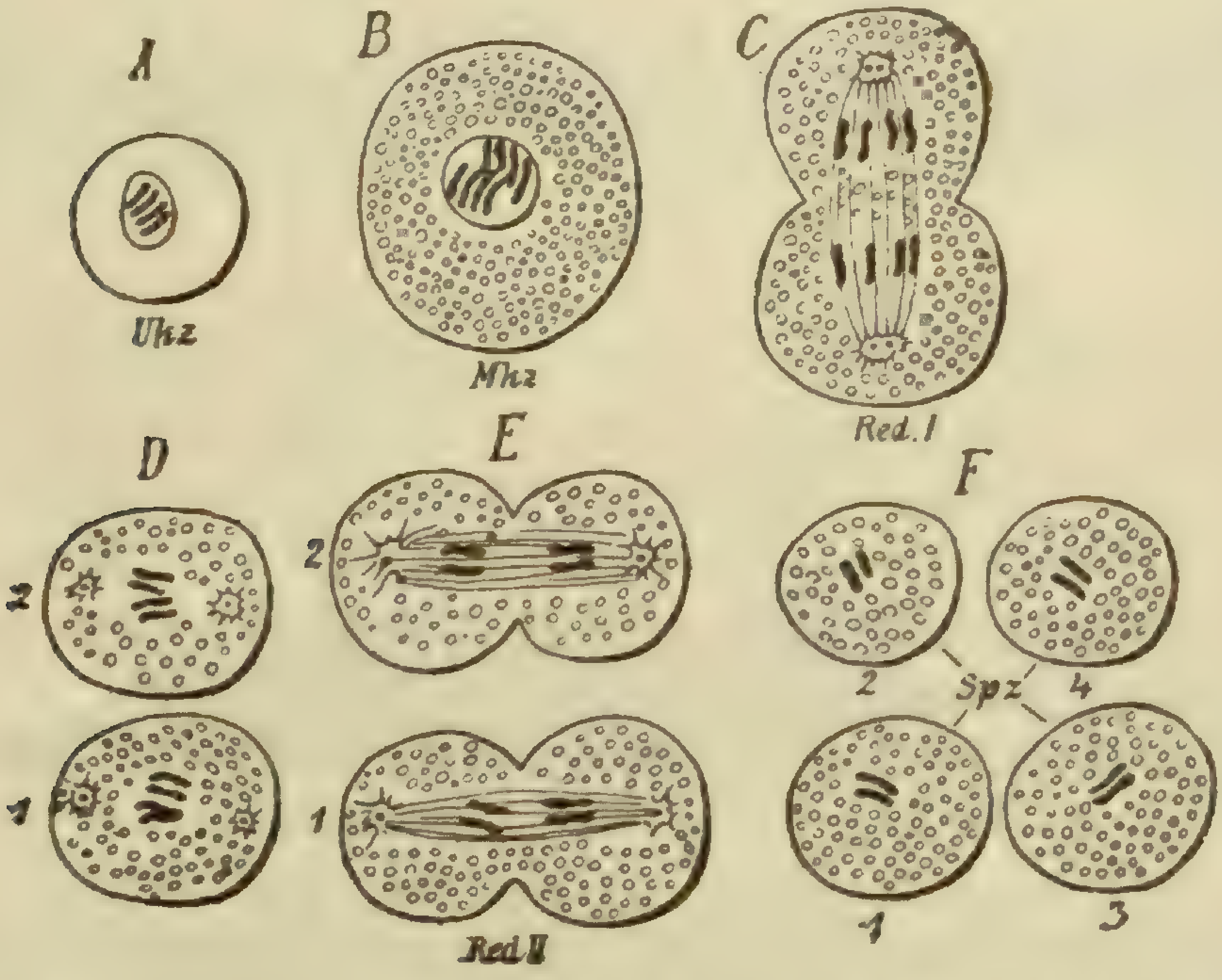

FIG. 12.—SPERMATOGENESIS IN ASCARIS. (From Weismann after Hertwig.) A, Original germ-cell—4 chromatin rods; B, Sperm mother-cell—8 rods; C-D, First daughter-cells with 4 rods each; E-F, Formation of second daughter-cells, or mature spermatozoa, with 2 rods each.

resting-period of the nucleus is omitted. Thus, he suggests, is prevented an over-accumulation of chromatin substance prior to the fusion of the ovum and sperm.

It is evident that the polar-cells are rudimentary ova, which do not possess the yolk-mass, etc., essential to development, and are divided off at a very late stage, sometimes after the egg has left the ovary, but are in other respects analogous to the spermatozoa. The reason these polar-cells have not disappeared altogether in either plants or animals is that they originally possessed a deep physiological importance. As the first polar-cell subdivides and forms two, it follows that from both ovum and sperm mother-cells four daughter-cells are

formed, each containing half the chromatin substance of a normal nucleus. In the ovary three of these daughter-cells abort and the fourth forms a true ovum: in the sperm-gland, however, all four daughter-cells form spermatozoa.

We may thus consider the polar-cell problem as in all probability settled; the whole process is probably an inheritance or survival of a primitive condition in which all four ova, like the four spermatozoa, were fully functional.

The Relation between the Chromatin and Heredity.—We have just seen that the last stages in the preparation of the ova and spermatozoa for conjugation result in halving the number of rods in the original germ-cells. Now, as Hertwig and Weismann point out, one point is still left in doubt. Why is the chromatin substance doubled in the mother-cells so that two successive subdivisions are necessary to reduce it to half the original quantity? Hertwig has not attempted to answer this question, as he prefers to wait for further research. Weismann, however, who is unfortunately cut off from research by failing eyesight, has offered a speculative solution to this problem which he trusts may guide future investigation.

This leads me to say a few words in regard to his conception of the relation of the chromatin to heredity. 1. His first premise is that in fertilization there is not a fusion of chromatin but that a certain independence is preserved between the maternal and paternal elements, based upon the observed fact that the two pairs of rods do not fuse but lie side by side, and upon the assumption that these pairs are kept distinct in each cell through all the subsequent stages of embryonic and adult development. If this be the case, the hereditary substance contributed by the father would remain separate from that contributed by the mother, throughout. 2. "Each of these pairs would be made up of the collective predispositions which are indispensable for the building up of an individual, but each possesses an individual character, for they are not entirely alike. I have called such units "ancestral plasms," and I conceive that they are contained in numbers in the chromatin of the mature germ-cells of living organisms, also that the older nuclear rods are made up of a certain number of these.

. . . Obviously these units cannot become infinitely minute; however small they may be they must always retain a certain size. This follows from the extremely complicated structure which we must without any doubt ascribe to them." These units are not, however, ultimate, they are in turn extremely complex, and are composed of countless biological units of the kind conceived by Nägeli and others. 3. The reduction of the chromatin only acquires a meaning when taken in connection with the above supposition of distinct ancestral plasms, and has no meaning if we accept Hertwig's view that there is a complete fusion of maternal and paternal germ-plasm. This meaning is that reduction in the maturation of germ-cells is *sui generis*, it does not divide the ancestral plasms into two similar groups, but one daughter-cell receives one set of germ-plasms or hereditary predispositions, and another daughter-cell receives another; reduction is thus differential. According to this view the four sperm and ovum daughter-cells would each contain a different set of ancestral plasms. 4. The fact that the chromatin substance is doubled in the sperm and ovum mother-cells, so that we observe double the number of rods characteristic of the species, is to be explained as an adaptation to the requirements of natural selection, for this doubling and subsequent double division render possible an infinite number of combinations (as many, in fact, as there are individuals) for Selection to operate upon.

This explanation of Weismann's is an example of his apotheosis of the theory of natural selection. Every process is made to suit this theory, which, as we have seen in the first and second lectures, is, in his opinion, the exclusive factor of evolution. But this very high degree of mingling and remingling of ancestral predispositions would be fatal to evolution, for after a combination favorable to survival had been established in one generation it would be broken up into a new combination, perhaps unfavorable to survival, in the next generation. This entire essay upon "Amphimixis," or the theory of mingling of reduced hereditary substance, will, I believe, mark a turning-point to decline in Weismann's influence as a biolo-

gist. His whole reasoning is now in a circle around the natural selection theory.

The Meaning of Conjugation.—Weismann looks upon sexual reproduction as designed to mingle hereditary tendencies and to create individual differences whereby natural selection may form new species. It is evident that these combinations must be mainly fortuitous and productive of indefinite variation; but we have seen that evolution advances largely by the accumulation of definite variations, or those in which each successive generation exhibits the same tendencies to depart from the typical ancestral form in certain parts of the body, and that these tendencies stand out in relief among the diffused kaleidoscopic or fortuitous anomalies.

The fact, moreover, that variability and evolution by the accumulation of certain variations in successive generations is also observed in organisms which reproduce asexually, both among plants and animals, shows that we must look in another direction for the underlying cause or purpose of sexual reproduction. Weismann rightly combats the old idea of "vitalization" of the ovum by the spermatozoon, and it is perfectly evident from the researches of Maupas and Hertwig that the ovum may as accurately be said to vitalize the spermatazoon as the reverse. Fecundation is simply the approximation of two hereditary substances of distinct origin and their incorporation into a single nucleus. The action and reaction of these substances may be considered equal and mutual so far as we now know.

The remarkably ingenious experiments of Hertwig and Boveri, above alluded to, strengthen this idea. Some years ago Weismann wrote: "If it were possible to introduce the female pronucleus of an egg into another egg of the same species, immediately after the transformation of the nucleus of the latter into the female pronucleus, it is very probable that the two nuclei would conjugate just as if a fertilizing sperm-nucleus had penetrated. If this were so, the direct proof that egg-nucleus and sperm-nucleus are identical would be furnished." Boveri succeeded in accomplishing a similar feat by depriving an ovum of its nucleus and subsequently causing it

to develop by admitting *a spermatozoan which fertilized the denucleated ovum and produced a complete individual!*

In opposing the vitalizing properties of the sperm, Weismann, however, went further, and advocated the view that there is nothing in the nature of vitalization or "rejuvenescence" in conjugation—that, given proper environment, protoplasm is immortal, and runs upon a course of undiminished activity. This we have seen is not the case in the Infusoria, and, as recently remarked by Hartog, there is only one class of organisms which, according to our present knowledge, are completely agamous and immortal—namely, the Monadina. It may in future appear that even in the monads there is a cycle for the development in which conjugation plays its part.

Maupas's experiments seem to establish the primitive, and therefore the true, interpretation of the purpose of conjugation as well as of sex, the latter being a consequence of the former, namely, that after a long period of direct subdivision of hereditary material from a single individual, a limit is reached beyond which the forces of heredity are not reproduced in their original intensity unless combined with another set of similar forces of different origin. This combination restores the original intensity. It is objected to this that two sets of feeble forces cannot constitute one vigorous force, but this is met by the observed fact that such union does start a new life cycle, and is therefore rejuvenescent. We may regard this as the fundamental meaning of conjugation and the production of variations as entirely secondary.

The Distribution of the Chromatin.—We have now reviewed some of the main phenomena of fertilization; there still remains the relation of the hereditary substance to the future development of the individual. There is, first, the astonishing fact that, as the chromatin goes on dividing, its mass or volume remains apparently undiminished; that is, there is apparently as much chromatin in one of the many million active cells of the body as in the original fertilized ovum, and there is still an enigma as to the nature of this chromatin and its functions. Secondly, there is the problem of the maternal and

paternal elements in each cell; do they lie side by side or are they fused?

1st. In plants De Vries[8] and others believe that all or by far the greater number of cells in the plant body contain the total hereditary characters of the species in a latent condition. Kölliker[9] has fully discussed this question and called attention to Müller's early views that, in spite of the physiological division of labor producing the tissues, the properties of all the tissues can be derived from the nuclear substance of a single tissue, as proved by experiments upon the lower animals. Weismann, on the other hand, has held that the course of development is marked by a constant qualitative distribution of his germ-plasm or hereditary substance, so that, so far as nuclear content is concerned, there are three forms of cells: 1, with nucleoplasm; 2, with nucleoplasm and germ-plasm; 3, with germ-plasm only. Kölliker opposes this idea and maintains that the "idioplasma" passes into all cells, in which it divides in course of development; step by step from the embryonic layers to the tissues, the constructive processes are under the direction of the nuclei containing this hereditary substance; it remains in every nucleus for a long period unaltered, in order to finally, here earlier, there later, impress its constructive forces. In certain elements, as in blood-corpuscles, epidermal scales, etc., it disappears, as the last product of division.

R. Hertwig takes a similar view; since embryonic and adult cell division is differential there must be a form of differentiation in the nucleus, but this does not consist in the total elimination of some qualities and survival of others, nor of a reduction in mass. The mass and the properties remain the same in every cell, the differentiation consists in the activity of certain elements in certain tissues. Thus we may say with De Vries, that different "pangene" may leave the nucleus and enter the cell in different tissues, or with Nägeli, that special "micellæ" come into activity at certain points; in other words,

[8]Hugo de Vries: Intracellulare Pangenesis. Jena, 1889.

[9]Die Bedeutung der Zellkerne für die Vorgänge der Vererbung, Zeit. f. wiss. Zoöl., 1885. And, Das Karyoplasma und die Vererbung, op. cit., 1886.

the potential of the nucleus is differently exerted. Here, again, we have the idea of patent and latent hereditary elements, such as appear in the entire individual upon a larger scale.

This is one of the most interesting problems for future investigation, but the direction of research will, I imagine, cover a larger area of cell-content than the nucleus, as we are now swinging back to regard the extra nuclear archoplasm as an important factor in the process.

In the following paragraph Hertwig expressed his view of nuclear control and cytoplasmic differentiation:

"As I saw in the transformation of the nucleus during fertilization proof that it is the bearer of hereditary substance I recognized a great advance in the fact that the nucleus leaves in the same form in every cell, and in its vesicular capsule is somewhat removed from the metamorphoses of the cells. As Nägeli spread his idioplasm as a net-work throughout the whole body, so, according to my theory, every body-cell contained in its nucleus its quota of hereditary substance, while its specific histological peculiarities were to be regarded as its plasma-products."

2d. The next question *is the fate of the maternal and paternal contributions to the embryo.* Here there is a wide difference of opinion. On the one side Van Beneden is the leader of those who regard each cell of the body as in a sense hermaphrodite; as we have seen, his views of maturation and the significance of the extension of the polar bodies were colored by this theory, for he regarded the germ-cells as hermaphrodite until one sex was eliminated. But now that the researches of Hertwig have given the last blow to Van Beneden's theory, and it follows that there can be no male and female chromasomes, there still remains room for the analogous view that the maternal and paternal chromasomes remain distinct throughout the course of development, not as sexual elements but as substances with the same racial and specific but different individual tendencies. Rabl, an eminent embryologist, shares this view, and it is supported by Boveri upon the observation that in each division the paternal and maternal elements are kept distinct, and in *Ascaris*, for example, two of the chromasomes

of each division figure are paternal and two are maternal. In favor of this hypothesis we may place the following facts: 1st, that there are an even number of chromasome rods in all cells; 2d, that the number is constant throughout all the subsequent changes in the tissues; 3d, that the number is fixed for each species or variety; 4th, that the number is the same in each sex.

Against this *replacement* hypothesis we must consider the extreme complexity of the division process, and the long-resting, or thread stage, in which the chromatin lies in a confused coil. Further, Hertwig argues that if the elements are distinct we should find some evidence that the maternal or paternal part is atrophied or replaced, or excluded from the nucleus, for both parts cannot share alike in the control of the cell. These are Hertwig's grounds for supporting the "verschmelsungstheorie," or *fusion* theory, also advocated by Waldeyer, to the effect that by the complete union of the maternal and paternal substance a new product is formed; in this fusion the law of prepotency may come into play, causing one or other of the parental tendencies to predominate, or there may be an even redistribution, whereby, as expressed by Hensen, "the hereditary substance of the son is not that of the father plus that of the mother, but is his own, with a new hereditary form resulting from the combination."

While suspending judgment between these two views as to the separation or fusion of the chromatin, we may appeal to the external phenomena of heredity for light upon the probabilities in the question. First, I refer to the very decided opinion of Francis Galton in regard to particulate inheritance; he is so impressed with the fact that we are made up bit by bit of separate structures derived from different ancestors that he has even suggested that the skin of the mulatto may represent not a fusion of white and black but an excessively fine mosaic in which the colors are so distributed as to give the appearance of blending. We do sometimes observe patches of color as evidence of uneven distribution. As Galton distinguishes two types of structures with reference to inheritance, viz., those which blend and those which do not blend, we might corre-

late these types with prepotency, replacement, and fusion. Where characteristics do not blend, as in eye-color, it is evident that, while the offspring must receive from both parents the material basis for the formation of the complete color of the eye, either the maternal or paternal material must be prepotent and exclude the development of the other; the logical inference is that the former actively replaces the latter; but it is not necessary that exclusion from the cell chromatin should follow. Now, while some blends seem to support the theory of fusion, the sum total of facts of heredity are strongly against this as a universal principle, for many maternal and paternal structures are preserved in their absolute integrity for generations without the least indication of mixture.

Cell Forces and Heredity.—We have thus far been considering only the chromatin as the heredity substance *par excellence*, and have disregarded for the time the archoplasm or dynamic material of the cell. If we advance upon the hypothesis that a typical cell contains the more or less passive chromatin, and the archoplasm playing upon this chromatin in course of every phase of redistribution, it seems *á priori* improbable that elements which are associated with every vital change should be dissociated in the phenomena of heredity. We might suppose that the mechanics of karyokinesis are exactly similar in every cell of one individual, but it is highly improbable that they should be exactly similar in two individuals. We should, therefore anticipate the joint transmission of the chromatin and archoplasm, implying by the latter the dynamic centers especially connected with hereditary function as distinguished from the general functions of metabolism.

This leads us to look for evidence from the life of the cell in its totality. We owe to Dr. Max Verworn[10] a fresh treatment of this subject, based upon experimental researches among the Infusoria, mainly by the extirpation method. As his experiments included only the phenomena of living cells

[10]Die Physiologische Bedeutung des Zellkerns, Archiv für Physiologie, 1891, pp. 113–115.

in which the chromatin substance was of course undifferentiated to the eye, he treats of the nucleus as a whole without distinction as to chromatin and achromatin. He concludes that the physiological importance of the nucleus is exhibited in its constant interchange of materials with the remainder of the cell body, only through this interchange does it influence the cell and control its life processes. The interchange is in triple currents, *a*, from outside of cell to cytoplasm; *b*, from cytoplasm to nucleus; *c*, from nucleus to cytoplasm. These movements of interchange are the expression of life phenomena. He compares the *rôle* of the nucleus to that of a cell organoid, like chlorophyll, as not constantly present but as invariably necessary to activity. Thus he believes even the most lowly organized cells have nuclear centres, and that even bacteria are differentiated into nuclear and extra-nuclear areas. Coupled with this idea of nuclear control is the somewhat paradoxical statement that the nucleus is not a dynamic centre, either automatic or regulating, and the conclusion that the nucleus alone cannot be the seat of fertilization and heredity, but both the nucleus and extra-nuclear protoplasm must constitute the material basis of heredity. This conclusion is in the direction of the general reaction of opinion which is now taking place against the centralization of cell-government in the nucleus.

Vague as they must necessarily be, our ideas of cell forces are somewhat further defined by the brilliant experiments of the Hertwig brothers upon germ-cell physiology and pathology, which are full of suggestion as to the causation of abnormalities in inheritance. These were begun in 1884 and were first directed to the influence of gravitation upon the planes of embryonic cell division, following up the experiments of Pflüger and Rauber. In 1885 the conditions of bastard fertilization were studied; in 1887 the causes of polyspermy or multiple fertilization: and in 1890 the effects of extreme heat and cold upon germ-cell functions.[11] In general the conclusions reached were that in the normal state there exist regulating

[11]Experimentelle Untersuchungen über die Bedingungen der Bastardbefruchtung, Jena, 1885. See series of papers in Jenaische Zeitschrift.

forces in the ovum which prevent multiple fertilization or bastard fertilization (*i. e.*, by spermatozoa of other varieties), but these forces are neutralized where the life-energy of the cell is diminished by reagents or by extremes of temperature.

For example, in the normal state the entrance of a single spermatozoon produces a reaction in the ovum-wall preventing the entrance of other spermatozoa, but when the ovum is weakened by chloroform solution two or more spermatozoa enter before the reaction appears; in fact the degree of polyspermy is directly proportional to the intensity of the chemical, thermic, or mechanical disturbance of the ovum. Double fertilization or over-fertilization has not in a single case resulted in the production of twins, so that Fol's supposition is negatived, although other forms may behave differently. The cell-function may be arrested at any stage by thermic influences; thus two pronuclei, paternal and maternal, about to unite can be held apart by lowering the temperature. Polyspermy also results from a lower temperature. It is noteworthy that the conditions of bastard fertilization and polyspermy are different; chloroform produces the latter but not the former. Kupffer has, I believe, succeeded in producing twins, or rather two-headed monsters, by abnormal fertilization in fishes.

These researches, although made with a different object, re-establish the older views as to the interdependence of nuclear and extra nuclear activities, and show that no sharp line of demarcation of function can be drawn between the nucleus as a center of reproduction and heredity, and the cytoplasm as the seat of tissue-building and nutrition. In Boveri's discovery of the archoplasmic centres, or centrosomes, we find positive ground for this broader view. It is connected with the cell phenomena of heredity in the following manner:

While the union of the nuclei in fertilization is the most obvious feature, this union is dependent upon the archoplasm, which rearranges the nuclear elements. If the spermatozoon contains no archoplasm, this power cannot come from the paternal side; but Boveri shows that this is probably not the case and that the spermatozoon brings its centrosome with it, thus entering the ovum with both the paternal chromatin sub-

stance and dynamic material. It is certain from this and from the observations of Roux that the sperm-cell is now to be regarded as more than a mere nucleus, that it contains both nuclein and para-nuclein.

Intercellular Forces.—The forces within the different portions of the cell lead us to consider those which must exist between different cells. This is an obscure question at present: but, as I have observed in the close of the second lecture, it is an extremely important one in connection with the problem of heredity. As Professor Wilson writes, "My own conviction steadily grows that the cell is not a self-regulating mechanism in itself, that no cell is isolated, and that Weismann's fundamental proposition is false."

It is a long step between an *á priori* conviction and the demonstration by experiment of a correlation of forces between the cells. This seems to me a most important field of experiment. We have seen in Maupas's work that the contact of two Infusoria initiates a rapid series of internal changes; we have only to conceive of analogous changes taking place when two cells are not in actual contact, as in the phenomena of previous fertilization referred to in my second lecture. Hertwig and others have shown how gravitation is related to cell activity. Roux has destroyed half an embryo with a hot needle in the first stages of segmentation and followed the other half through the stages of subsequent development. Another clever experimenter has turned fertilized ova upside down during the early stages of development, and shown how the protoplasmic pole and yolk-pole forcibly change places. Driesch has traced the connection and meaning of the first plane of cleavage in the embryos of echinoderms, and has succeeded in raising a small adult from half an embryo artificially separated during the first cleavage stage. Wilson, in the larva of Nereis, has shown how a certain stage of division in one group of cells affects all the other groups. All these experiments are in the line of determining the relation which exists between internal cell forces and other natural forces. What we must now seek to determine is the relation of cell to cell throughout the body, in connection with the phenomena of heredity.

Conclusions.—The most impressive truth issuing from our review of recent researches in evolution and heredity is the uniformity of life-processes throughout the whole scale of life from the Infusoria to man. The most striking analogy is that seen in the laws of fertilization and conjugation, which are shown by Maupas's researches to have been established substantially in their present form at a very early period in the evolution of living organisms. Such uniformity furnishes a powerful argument for the advocates of the study of biology as an introduction to the applied science of medicine. Much that is now entirely omitted from medical education, because it is considered too remote, is in reality at the very roots of the science. To understand the disorders of life we should first thoroughly understand the essential phenomena of normal life. Of course we shall never see life as it really is, because there is always something beyond our highest magnifying powers; but we come nearest to this invisible form of energy when, with such investigators as Hertwig and Maupas, we strip the life-processes of all their accessories and view them in their simplest external form.

The problems of evolution are found to be inseparably connected with those of heredity. No theory is at all adequate which does not explain both classes of facts, and we have seen that the explanations offered by the two opposed schools—those who believe in the transmission of acquired characters and those who do not—are directly exclusive of each other. We should suspend judgment entirely rather than cease to gather from every quarter facts which bear upon the most important and central problem of the transmission of acquired characters. I have endeavored to point out the opportunities which medical practitioners enjoy of contributing evidence upon this mooted question. It must not be forgotten that while the inheritance of individual adaptation to environment is the simplest method of explaining race adaptation such as we observe in the evolution of man, we know absolutely nothing of how such inheritance can be effected through the germ-cells. We cannot at present construct even any form of working hypothesis for such a process. On the other hand, we

have found how untenable is the alternative theory offered to us by Weismann, that it is solely natural selection or the survival of the fittest which

> ". . . shapes our ends,
> Rough-hew them as we will."

At the same time Weismann's conception of a continuity of germinal protoplasm, which we have found to consist in chromatin plus archoplasm, helps us over many of the phenomena of heredity, especially on the retrogressive side, and if it were not that we must also account for progressive and definite transformation in heredity, we might credit the distinguished Freiburg naturalist with having loosed the Gordian knot.

In summing up, the order of treatment followed in the lectures may be reversed, and we can begin with the germ-cells, and condense the more or less ascertained facts.

The Germ-cells.—1. The material substance of hereditary transmission is the highly coloring protoplasm, or chromatin, in the nucleus of the germ-cells, probably connected with a certain form of archoplasm, or dynamic protoplasm, outside of the nucleus.

2. Before conjugation and fertilization the hereditary substance of both the male and female cells is reduced to one-half that found in a typical cell. The substance is, however, first doubled and then quartered, the meaning of which process is not understood.

3. There is a difference of opinion as to whether the paternal and maternal hereditary substances, are fused or lie side by side during fertilization, also as to how the substance is distributed through the tissues, during individual growth, whether *en masse* or by qualitative distribution.

Heredity.—4. No form of physical connection between the germ-cells and body-cells is known, but the facts of heredity seem to render such a connection theoretically necessary. Several classes of facts witnessed in reproduction seem to support this theory.

5. The facts of Heredity support the theory of a continuous and specific form of protoplasm as the basis of repetition of type.

Evolution.—6. The facts of evolution, both in present and past time, point to transformism by definite progression toward new types of structure in succeeding generations, opposing the retrogressive forces of heredity.

7. The theory (Natural Selection) of definite progression by the accumulation of fortuitous favorable variations is found to be not only theoretically improbable, but not to correspond with the observed laws of variation.

8. The laws of variation (anomalies) lend support to the theory of hereditary transmission of individual acquired variations, but even this (Lamarckian) theory encounters many difficulties.

I think this is as fair a statement as can be made at the present time, and it rests upon a general survey of the whole field.

THE HEAD OF AN EMBRYO AMPHIUMA.

By J. S. Kingsley.

The following is a preliminary account of some studies of a single stage of *Amphiuma means* before hatching. For the material I am under great obligations to Prof. O. P. Hay, of Irvington, Indiana. I must also return my thanks to Prof. Dr. Robert Wiedersheim, in whose private laboratory in the University of Freiburg i-B., my studies were conducted. Only one who has enjoyed the privilege of working with him can appreciate his many kindnesses and extreme helpfulness.

External appearance.—The general appearance of the eggs has already been described by Dr. Hay, and is strikingly similar to that of Ichthyophis as described and illustrated by the cousins Sarasin. This resemblance is strengthened by the fact that the cord connecting the eggs is spirally twisted as in the Ceylonese Gymnophione described by them.

The external description of the embryo Amphiuma has been correctly described by Hay in most points, but in a few respects my specimens differ from his description. According to him "the gills consist of three pairs, and are of the simply pinnate form. . . Only once have I observed any of these lateral filaments to divide. . . Three gill slits are still open." The figures which illustrate this are strikingly like those of the Sarasins of the branchiæ of the Ichthyophis larvæ. In the larvæ which I studied the resemblance is not so striking. The three gills of either side are united at the base into a common trunk, the gill filaments are not bipinnately but irregularly arranged, and in none of my specimens have I found more than one gill cleft open. (*Cf. infra.*)

Chondrocranium.—The cartilaginous skull, as it appears in a wax reconstruction after Born's method (and compared with dissections), is more slender than in Hay's figures; it also presents minor differences in several other respects from his rep-

resentation and description, to which reference should be made in reading the following account:

In front of the pituitary space the trabeculæ unite into a broad horizontal plate, the line of junction of the two halves being entirely obsolete, while still farther forward the cornua trabeculæ, instead of being two-lobed, form a broad triangular plate. Between the two cornua is a deep and narrow notch with parallel sides in which is imbedded the septum osseum of the premaxilla to be described below. The trabeculæ, on either side of the pituitary space, are high and compressed. Just behind the nasal capsules two processes are given off on either side. The upper one, arising from the trabecular crest is, as Hay calls it, the rudimentary nasal capsule, and in one specimen upon one side I found a perforation in this process which suggests the more extensive fenestration in the nasal cartilage of the adult Necturus and Protopterus. The lower process may retain the name, antorbital, usually applied to it, for Amphiuma presents no evidence that it is the palatine cartilage as Gaupp interprets it.

Somewhat farther behind these processes than in Hay's figure are two openings through the trabeculæ for the passage of the optic and oculomotorius[1] nerves.

The trabeculæ are united to the posterior portion of the cartilaginous skull by three processes. The upper connects the crista trabeculæ with the ear capsule; the middle, the process ascendens of Stöhr and other authors, goes from the trabeculæ to the inner anterior angle of the quadrate; the third, the radix trabeculæ, is bifurcate posteriorly, the outer ramus joining the floor of the otic capsule, the other uniting with the parachordal floor of the cranial cavity.

The parachordal cartilage lies beneath the notochord, as do the lower arcs of the occipital and first cervical vertebræ. Between the parachordals and the otic capsule on either side is a large oval opening in the cranial floor. The occipital vertebra is confluent below with the parachordal cartilage; on

[1]Hay suspected that the posterior of these foramina was for the transmission of the third nerve. I have traced the nerve from its origin, through the opening, into the proper eye muscles.

either side it merges with the posterior angle of the otic capsules; above it is incomplete. Between the ventral portion of the occipital vertebræ and its lateral union with the otic capsule is the foramen for the vagus nerve.

The otic capsules are elongate oval. In front they project slightly beyond the point of union with the cristæ trabeculárum, behind they merge into the occipital vertebra. In the lower outer surface is the large oval foramen ovale, and just in front of it is the external opening of the foramen for the facialis. This foramen does not penetrate the ear capsule proper, it only passes through its anterior wall. On the inner lower surface the otic capsule is produced into a narrow ledge which projects inwards to form a part of the floor of the cranial cavity, being limited internally by the large opening between it and the parachordal cartilage. The inner wall of the capsule is perforated by three subequal openings in the same plane, and a fourth smaller one above them and between the two posterior ones. The anterior of these forms a considerable cavity, in which is situated the acustico-facialis ganglion and from it nerves go through the adjacent cartilage in the following directions: One branch, the ramus palatinus, goes ventrally through the floor; a second, the facialis proper, goes straight outward to reappear, as just mentioned, upon the outer surface; while the third, the ramus vestibularis of the eighth nerve, goes upward and backward to the sensory epithelium of the inner ear. Separated by a considerable cartilaginous interval from the first of these openings is a second, nearly equal in size, through which the ramus cochlearis of the auditory nerve enters the ear; the small upper opening permits the ductus endolymphaticus to pass above the brain in the same manner that the ductus perilymphaticus goes through the fourth opening beneath the brain. I have seen no special opening in the cartilage for the passage of blood-vessels to the inner ear.

Cartilaginous Visceral Skeleton.—The quadrate is rhomboidal in outline when viewed from the side, the external surface exhibiting a slight depression. As yet it is connected with the skull by only the process ascendens, the processes

oticus and palatobasale being as yet undeveloped. Behind, from the posterior angle, is a projection with which articulates the cylindrical process opercularis (columella), the posterior end of which is imbedded in the still membranous opercular membrane (stapes of Hay), which closes the foramen ovale. Meckel's cartilage articulates with the lower angle of the quadrate, a process extending behind the articulation, for the insertion of the digastric muscle. The two halves of the lower jaw are united by fibrous connective tissue in front. I find no trace of Hay's pterygoid cartilage. The hyoid and branchial arches call for no remark aside from the fact that they lack the yoke which binds together the upper ends of the branchial bars in Amblystoma embryos, and, according to Stöhr, in some other forms.

Ossifications.—These have been well described by Hay and only a few words are necessary. The ossifications are here, as Weidersheim has pointed out for all urodeles, perichondrostoses. They consist of, in the cranium at this stage, premaxillary, vomeropalatines (better dermopalatines), parasphenoid, frontals, parietals, squamosals or tympanics, occipital and small patches surrounding the exits of the vagus nerves. In the lower jaw dentary and angular bones are seen, while ossification occurs on the hyoids. The premaxillary at this comparatively early stage shows no trace of a double origin, either in front or in that median osseous process extending backwards, which separates the two nasal cavities. This is the septum osseum of Weidersheim, and is clearly a portion of the premaxillary. It is also, I think, the same bone which Cope has called ethmoid, and upon which both he and the Sarasins have placed great weight in their association of the Gymnophiona with the Amphiumidæ. The squamosal of Amphiuma is clearly not homologous with that bone which Weidersheim (and following him Cope) has called by that name in the Cæcilians, but to which the Sarasins have applied the name jugal. The ossification of the occipital region is peculiar. As is well known the occipital region of the urodele skull is formed by the junction of a primitively separate vertebra with the parachordals and otic capsules. In this vertebra, above its carti-

laginous lower arch and in the fibrous connective tissue on either side of the notochord is a deposit of bone of such a character as to suggest the existence here of an earlier vertebral centre which has disappeared.

VISCERAL CLEFTS.—My specimens are too old to throw any light upon the mooted question of an obsolete visceral segment between mandible and hyoid, but in the region behind the last branchial cleft of the ordinary Amphibian some interesting facts are seen. A reconstruction of the floor of the throat after the method of Born shows the following clefts distinctly: —*a*, the hyomandibular or spiracular cleft, which like *b* and *c*, the first and second branchials, is not open to the exterior; *d*, the third branchial cleft which is still functional, opening to the outer world as already described in referring to the external appearance. Behind this last cleft comes the fourth cartilaginous gill arch; and still behind this and between it and the trachea are two other pits, clearly serially homologous with the others, and hence to be regarded as the representatives of the two posterior clefts of the typical elasmobranchs and ganoids. Of these the anterior (fourth branchial) has already been recognized as occurring in the Amphibian ontogeny; it is the "Suprapericardialkörper" of authors, which Maurer has shown to be the fourth gill cleft. The posterior, the fifth gill cleft has not before been recognized in the Batrachia. These posterior clefts bear such relationships to the trachea as to lend countenance to that view which would derive lungs and trachea from modified gill slits. Should this view ever be substantiated, it may be that the laryngeal cartilages will be shown to be the modified gill-bars of this region. Amphiuma, however, throws not the slightest light directly upon the phylogeny of these structures.

In this connection I may state that in the early Siredon stage of *Amblystoma jeffersonianum* the posterior (fourth) branchial cartilage is bifid at its upper and posterior extremity[2] in such a manner as to suggest that there was formerly here an additional arch, the traces of which are disappearing in the same way in which the posterior gill of Ichthyophis is

[2] This, of course, bears no relationship to the bifid ceratohyals of the ganoids.

merged with its predecessor. In Amphiuma I find no trace of any gill bar behind the fourth of the adult.

Nervous System.—The brain of the larva studied varies considerably from that of the adult as described by Osborn. The account of the internal structure is reserved until later. Externally it is characterized by its shortness and longitudinal compression, this being more marked than in any adult Batrachian except that of the Gymnophiona as described by Waldschmidt and Burckhardt. It exceeds in this respect the brain of Protopterus as figured by Fulliquet. As in the latter form the cerebral hemispheres are pushed back upon and wedged apart by the twixt brain, while behind, the mid-brain and cerebellum are so folded over upon the medulla that the lateral angles of the 'fossa rhomboidalis' extend nearly to the posterior lobes of the cerebrum.[3] The brain flexure, however, is apparently slight, the primary bend being corrected by a secondary one. The cerebral hemispheres are distinct above and in front of the lamina terminalis; the olfactory lobes are not distinct from the hemispheres. The floor of the twixt brain is very short and the infundibulum and hypophysis are very broad, the latter being wider than the mid-brain in its widest place. The choroid plexus of the anterior ventricles is well developed, but calls for no special remark. The cavity of the pinealis is still in connection with the cavity of the brain and its enlarged distal portion, which reaches nearly to the roof of the cranial cavity, is considerably lobed and folded.

The olfactory nerve arises by a single root,[4] goes laterally from the tip of the hemisphere and, in the nasal capsule, divides into upper and lower branches which innervate the nasal epithelium and Jacobson's organ respectively.

The optic and oculomotor nerves call for no comment. I failed to find the fourth (trochlearis) and the sixth (abducens) in my preparations.

The fifth nerve presents several features of interest. As my

[3]Cf. Waldschmidt's account of the Gymnophionan brain.

[4]Weidersheim formerly thought that the double origin of the olfactory in the Gymnophiona had great morphological importance, but the studies of the Sarasins and of Burckhardt show that such is not the case.

material was none too well preserved, I am not able to say how many roots the nerve has, as it comes from the brain. Several distinct groups of fibres go from the anterior angle of the medulla to the gasserian ganglion. This latter structure is single and shows none of the double character described by von Plessin and Rabinowicz[5] in *Salamandra maculata.* Nor do my studies of the nerve fibres agree with their accounts of the nerves. The Gasserian ganglion is oval in shape. It lies in the angle formed by the otic capsule, the processes of the trabeculæ and the process ascendens of the quadrate. From its hinder surface a commissure connects it with the ganglion acustico-facialis. From its outer surface arises the maxillaris inferior, and from its anterior end, at different levels, the rami ophthalmicus superficialis, ophthalmicus profundus and maxillaris superior. The maxillaris inferior and the maxillaris superior, after leaving the ganglion, pass from the cranial cavity between the process ascendens of the quadrate and the otic capsule. According to von Plessin and Rabinowicz these rami are different in cerebral origin in *Sal. maculata*, but in my section some of the fibres which compose each are easily traced to a common origin. Of the distribution of these nerves nothing need here be said.

The two ophthalmici leave the cranial cavity through the foramen below the process ascendens of the quadrate. The ophthalmicus profundus passes beneath the optic and oculomotorius and breaks up into fibres at the posterior wall of the nasal capsule. Fibres from the ganglion of the seventh are traced through the gasserian ganglion into the ophthalmicus superficialis.

The compound facialis-auditory ganglion is long and narrow. From it arises the palatine branch which goes through

[5]According to these authors the Gasserian ganglion consists of two distinct and separate ganglia: a ventral principal ganglion and a more dorsal accessory portion. The chief ganglion has its proper medullary root, while the root of the accessory ganglion is close by and a little dorsal to the root of the acustico-facialis. From the principal ganglion arise two nerves, called respectively mandibularis (= maxillaris inferior) and nasalis (= ophthalmicus profundus); from the accessory ganglion arise the supramaxillaris superior (= maxillaris superior) and the frontalis (= ophthalmicus superficialis).

the floor of the otic capsule to be distributed as usual. The facialis branch divides into two portions just outside the cranial wall and behind and below the quadrate; the very large posterior branch runs backward to innervate the posterior belly of the digastric muscle. The anterior ramus has the usual distribution.

An especially noticeable feature in connection with the twelfth nerve is the persistence of the dorsal ganglion. Waldschmidt's observations on Protopterus and those of von Plessin and Rabinowicz upon Salamandra are interesting in this connection.

The nasal organ has a well developed organ of Jacobson, though on a simpler type than that of the Cæcilians. The sensory epithelium of the nose, is in these embryos, not differentiated as in the adult.

Conclusions.—Following such students of the Batrachia as Cope and the Sarasins it is with some diffidence that I dissent from their conclusions, for both regard Amphiuma as a connecting link between the Cæcilians and the Urodeles. That both Gymnophiona and Amphiuma are degenerate goes without question, but it seems to me that their many peculiar resemblances are those of homoplassy rather than derivations from a common ancestor. Then again, some of these resemblances have been founded upon mistakes. Thus the possession of an ethmoid by Amphiuma cannot be maintained. The external gills of the larvæ are not so similar as has been supposed; the derotrematous condition which appears later has one important difference: In Amphiuma only the third gill slit persists to open through the round external opening to the exterior, and my material shows that when the other slits were open they had separate openings upon the side of the neck. In Ichthyophis, on the other hand, the observations of the Sarasins show that both the second and third slits have a common external opening.

On the other hand, there are certain differences to be emphasized. The presence of an ethmoid in the Gymnophiona (and its absence from Amphiuma and other Urodeles[6]) the exist-

[6]The ethmoid of H. H. Wilder in Siren is clearly not homologous with the bone (mesethmoid) called by that name in other vertebrates. It is rather the prefrontal of authors.

ence of a turbinal, the absence of a parasphenoid and the presence of a basisphenoid are all points of importance, as is also the frequent presence of two rows of teeth. Again, in the Cæcilians we find a multiplicity of bones such as occurs in the lower Ichthyopsida but not in the Urodeles, and which consequently cannot be derived from the latter. Regarding the chondrocranium of the Gymnophiona no comparison can be made until the appearance of the promised paper by Burckhardt.

The view is quite common that the origin of the Batrachia (sens. lat.) must be sought in the Dipnoi. Thus Cope says (AM. NAT., xviii, p. 725–6, 1884): "The Batrachia have originated from the sub-class of fishes, the Dipnoi, though not from any known form."

This view had doubtless its foundation in the existence of both gills and lungs in these forms. As yet, however, no careful study of the distribution of the cranial nerves and of the ontogeny of the chondrocranium of any Dipnoan has been published, and until we have more detailed accounts than have as yet been made it is safe to assume that the resemblances which have been pointed out between the Dipnoi and the Urodeles are those derived from a common ancestry. Of these resemblances probably the most important is that of the relation of the mandibular arch to the skull. Thus Huxley has divided the Ichthyopsida into autostylic, hypostylic and amphistylic groups, and has shown the close resemblances of the Amphibia to the Dipnoi, Chimæroids and Marsipobranchs in the ampistylic character of this connection of the quadrate with the cranium. It is, however, to be noticed that in the Urodeles the pterygoid cartilage never has that close relation to the cranium that this thesis demands, while the autostylic condition arises comparatively late in development, and never attains that completeness which a Dipnoan ancestry would imply.

In short, I would prefer to trace the origin of both Dipnoi and Urodeles from a crossopterygian ganoid ancestry, the former being the apex of their line of development, the latter tracing their descent through the Stegocephali.

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IMPORTANCE OF THE SCIENCE AND OF THE DEPARTMENT OF PREHISTORIC ANTHROPOLOGY.

By Thomas Wilson.

Prehistoric Anthropology is a new science. During the past eighteen hundred years the Christian, and consequently the civilized world, has, until the beginning of the nineteenth century, lived on in the belief that man's appearance upon earth dated no more than 4,000 years before the commencement of our era, and it was without knowledge of the prehistoric man, nor did it have a suspicion of his existence.

The wise men of Denmark in the early part of the nineteenth century, while studying the characters engraved on their runic stones and the legends in their sagas, discovered evidences of a human occupation of their country earlier than any of which they had heretofore known or suspected. This occurred about 1806, and in 1836 Mr. Thompson, the renowned Danish archæologist (who founded and for fifty years directed the prehistoric museums at Copenhagen), published his first memoir in regard to prehistoric civilizations, which he named after the material principally employed for cutting implements, "The Ages of Stone, Bronze and Iron." These divisions have ever since been universally accepted.

In 1854 Dr. Ferdinand Keller recognized at Meilen, on Lake Zürich, Switzerland, certain evidences which developed into our present knowledge of the Swiss Lake Dwellers, although it has since been proved that lake-dwellings existed in many other countries in Europe.

Beginning with 1841 M. Boucher de Perthes, residing at Abbeville on the river Somme, discovered certain flint implements rudely chipped in the shape of an almond or peach stone with the cutting-edge at the point. He had found them deep in the gravelly terraces of the river Somme, and in such position and association as to force the conclusion that they

were the handiwork of man and of an antiquity before unsuspected. He continued his labor, gaining converts with indifferent success, until the year 1859, when, by agreement, a committee of fifteen gentlemen, supposed to be the best qualified for the task, and in their departments certainly the most learned men of France and England, met on the ground to make personal investigations. After discussion, dispute, and difference of opinion, of which I need not speak here, it was finally decided that M. Boucher de Perthes was correct in his theory, and that these implements were the work of men and of an antiquity heretofore unknown.

Here was born the new science of Prehistoric Anthropology, and since then it has not only become recognized as a science, but whenever and wherever studied and understood it has increased in dignity and importance.

I said a few lines back that the civilized world had, until the beginning of the nineteenth century, lived without knowledge of the prehistoric man and without even a suspicion of his existence. This is more true in Europe than in America. The knowledge of prehistoric man began on this continent several hundred years before it did in Europe. Columbus formed his acquaintance on the discovery of America. The white men on arriving beheld the prehistoric man face to face, and had ample opportunities for knowing, studying him, and finding out everything that was discoverable from contact with him. Though many books have been written about the prehistoric man of America, and their authors have described him as they saw him, yet we know but little of his true nature. The scientific study of this subject has begun only of late years, and we are still ignorant concerning his history or life prior to the discovery of America in 1492; whence he came, to what race he belonged, or what were his habits, customs or monuments. We are even wanting in knowledge of those things peculiar to him since that time, and which have been manifested to us in every period of our contact with him. The study of his language, socialogy, religion, mythology, has just commenced. Many men have written descriptions of their visits to the Red Man of North America, have given his-

tories of their travels, and have written entertaining books on the subject; but these have largely been fugitive, isolated and without connection with any other than the tribe visited, the voyage described, or the travel undertaken. Nor was there any connection proposed between these writers who might have taken up the same line of investigations with other tribes or other parts of the country. I would not dwarf or belittle the labors or discoveries of our pioneers, but conceding for them all that their friends can claim, they have done but little towards giving an accurate anthropological and ethnological history of the North American Indians. As to their history in prehistoric times, before Columbus, no attempt was made by these historians. Collections have been made of the implements of the North American Indian, and large prehistoric museums established in nearly all parts of the United States, beginning back a hundred years or more, which are and will be of great interest and value in writing such a history. But in the majority of these cases the work has been that of collectors, sometimes for commerce, but more often to gratify that thirst for things of antiquity which seems to be second nature of mankind. A study of anthropology will scarcely be claimed by any one as the motive on which these collections were based. So, while we have had an earlier knowledge in America of prehistoric man, yet it has not attained to that dignity and importance as a science as it has in Europe.

The Smithsonian Institution, National Museum, Bureau of Ethnology, Peabody Museum, and several other institutions whose names will occur to the reader, are exceptions to this statement. The number of private persons who are giving serious attention to this science and are doing faithful and valuable work in this connection are increasing every year. My remarks have not been intended as any reflection upon them or as criticisms of their methods, but are aimed at that great body of persons who, interested or pretending to be interested in the study of anthropology, are naught but collectors of Indian relics, who gauge the value of their specimens, if not solely from a monetary point of view, from their number, beauty, and rarity. They do not count their collections as

of value to the sciences or as an aid in solving the great problem of prehistoric man, but regard them as so many trinkets to gratify their own pride or excite the envy of their less fortunate neighbors.

I have considered as part of my duty the endeavor to awaken and elevate the public mind to the importance of the science of prehistoric anthropology, to so far as possible prevent the search for Indian relics as a matter of commerce, and cause collectors to regard these objects in their true light as aids to science, not as gewgaws and trinkets.

In the performance of this duty I have, during the past year, delivered ten public lectures, distributed from my office a thousand or more copies of Circular 47, descriptive of the prehistoric exhibit at the Cincinnati Exposition that has a bearing in this direction, and my Handbook of Prehistoric Anthropology, No. 743, which, it is to be hoped, will not be without effect.

There has also been prepared a circular (No. 49) relating to prehistoric anthropology and containing information for the guidance of explorers and collectors.

Despite the fact that the discovery of prehistoric man in Europe was made so many years, possibly so many hundreds of years, after his discovery in America, yet I am compelled by the facts to declare that Europeans, because of their interest in the new science, have established prehistoric anthropology on a much broader basis and a firmer foundation, and have given to it more thorough and scientific treatment than has been done in the United States. If I make a comparison in this regard between the two countries as to the detriment of our own it will only be that we may benefit thereby, may take warning and so redouble and direct our efforts, using the opportunity and material which we have in such improved methods and increased endeavors that in future years the difference will not be to our disadvantage. If the following statements will direct the attention and increase the energy of our scientists to proper exertion in this regard I shall feel amply repaid for my labor.

Our acquaintance with the aborigines of this country began with Columbus in 1492, but the real history and our first actual knowledge of them began no earlier than 1600, probably 1604 or 1608, now only 280 years since. Americans, therefore, of the present day, are only removed from the prehistoric man of the whole country by that period, nor is it even so long, for this was the commencement of our knowledge. The authors at that time saw him face to face, were able to describe, and wrote their histories of him. He has continued with us ever since, and we have from that time to the present had full and ample opportunity to increase our informatien concerning him by investigation, examination and personal contact.

In France and England, in fact over Western Europe, the period when the last possible contact with prehistoric man could have taken place, the time when all our knowledge concerning him acquired from observation ended with the invasion of Cæsar. So that while the American has not to go back farther than 280 years to study the prehistoric man of his country, and has had him present ever since, the Englishman and Frenchman has to go back nigh 2,000 years; and their opportunities of personal contact ended then if it had not before. It is not at all certain that the Gaul and Briton of that epoch is the real prehistoric man. He may have been related to him, possibly his descendant, but it appears that the prehistoric bronze age had practically ended in that country, and the iron age begun from four to nine hundred years before the advent of Cæsar.

I have said this much to show the difference in the respective opportunities for the study of prehistoric man between Europeans and Americans.

The territory of France is about 200,000 square miles; that of the United States is about 3,600,000, eighteen times larger than France. Mile for mile and acre for acre, the United States will yield as much to the student of prehistoric archæology as will that of France, yet with this difference in area of equal fruitfulness, the United States government is far behind that of France in its interest and assistance given to this science.

Compare the National Museum of France, to wit, that of St. Germain, with my department of the National Museum of the United States. The St. Germain Museum is installed at St. Germain-en-Laye, a few miles out of Paris, in the palace of that name, built by Francis I. I have not the exact dimensions, but it is in the form of a triangle. The front or shortest leg is, I should say, 400 feet long. It is given up entirely to the officers of the institution, and the chambers are living apartments of the officers. The other leg of the right angle has been fire-proofed throughout and completely restored, and it now consists of exhibition halls. This restoration is being continued upon the other wing. The work began in 1879 and is not yet completed. The building is four stories high, and there are now twenty-five halls filled with prehistoric objects open to the public. One entire story is devoted to each the paleolithic and neolithic periods of the stone age, and one to the bronze age, while the basement contains the heavy stone principally architectural monuments of the Roman occupation. Except in the latter, the display made, the objects shown, the epochs, periods, or ages represented, are the same as those now crowded into my one hall. With all her wealth of antiquity, with all the extent of territory, eighteen times greater that of France, the United States devotes to the objects and implements of her prehistoric races less than one-eighteenth part of the museum space occupied by France.

In the management and direction of this museum and of the matters pertaining to this new science there exists about the same difference. The Director of the Museum of St. Germain is a member of the Institute, and approximates in the dignity and importance of his position, to that of the Secretary of the Smithsonian Institution and Director of our entire National Museum. The work belonging to our Bureau of Ethnology is in France committed into the hands of a commission of savants, to which M. Henry Martin, the great French historian, was and M. Gabriel de Mortillet, Depute is the chief.

I shall not attempt to compare the work of this commission with its representative in the United States, but I may indi-

cate the difference when I say that the monuments belonging to the prehistoric age which are attached to the soil and part of the real estate, which have been purchased, restored and are now owned by the Government of France are to be numbered by the hundred.

The Department of Prehistoric Anthropology in the British Museum has for its curator a person, eminent in the ranks of the science, who receives a salary of fifteen hundred pounds per annum, equal to $7,500, a greater sum than is expended in any one year for my entire department. $6,000 are set aside yearly for purchase of specimens.

The Museum of the Irish Academy of Dublin possesses a greater value in prehistoric gold ornaments alone than it has cost the United States for our entire Museum with all its specimens, service, management and furniture.

The Prehistoric Museum of Antiquities at Edinburgh, Scotland, is also extensive. It is devoted exclusively to the antiquities of its own country and forms a complete museum of itself. It has for curator and staff, Prof. Anderson; Dr. Arthur Mitchell and Mr. Black, names that stand as high in their science as do any others of their country in any science.

The Prehistoric Museum at Copenhagen is so extensive and rich that it might be classed as one of the wonders of the world. It occupies the entire Prinsens Palais, has eight exhibition halls, with a full corps of professors, curators, etc., who occupy the highest ranks in science. The riches of this museum are almost beyond computation; 10,000 polished stone hatchets and axes, the contents of eleven workshops, one of which alone furnished 200 hatchets, 58 perforators, 4,000 scrapers, 1,426 arrow-heads, *trenchant transversal.* Fifty-one cases of bronze implements and ornaments, gold objects so numerous and valuable that kept, of course, during the day under lock and key, they are taken out each night and stored for safety in an immense steel safe.

Stockholm has a National Museum devoted entirely to prehistories, for which the government has organized a bureau and erected a fine museum building, with Messrs. M. Hilderbrand as curator and M. Montelieus as assistant.

The University of Lund devotes the basement story to its prehistoric museum, with Prof. Soderberg for its professor and lecturer.

The University of Upsala, one of the finest and oldest in all Europe, is engaged in the same direction.

The University at Christiana, Norway, has the same kind of arrangement. Rygh and Undset are its professors. An idea can be had of the importance with which this prehistoric science is viewed in this country when I say that while the Numismatic Museum at Christiana possesses a finer collection of United States coins and medals than does our National Museum, yet their desire to keep their own antiquities is so great that they refuse to exchange them for those of any foreign country.

The mention of these Scandinavian museums with the names of some of their professors will give but a faint idea of the dignity which has been accorded to the science of prehistoric anthropology in these countries, and the attention which it has there received. These countries are entitled to the priority of discovery of prehistoric man, and they have maintained a leading place in the science. So much so that he who was its acknowledged head in Europe and the world, Worsaae, was taken into the King's Cabinet and served the latter years of his life as Minister of Public Instruction.

I need not mention the great prehistoric museums of Germany. That at Berlin with Virchow, probably the leading anthropologist of the world, at its head, Dr. Johanas Ranke at Munich, and so they are dotted over the country in every city from the Baltic to the Alps.

Much might be expected from Switzerland, for it is the land of the prehistoric lake dwellers, and she has not disappointed our expectations. Bern, the capital, has no less than three governmental prehistoric museums: one belonging to the Republic was purchased by it lately from Dr. Gross, of Neuveville, for the sum of 60,000 francs. The canton and the city each own a museum of no mean extent, where are gathered and displayed all objects found in the neighborhood. The other cities and cantons of Switzerland are equally alive to

the importance of this science, and equally active in its study and pursuit. Geneva, with Dr. Gosse at its head, Lausanne, with Morel-Fatio, Yverdon, Neuchatel, Bienville, Steen, Constance, Zürich, all are active, energetic and industrious in gathering the objects in their vicinity, in enlarging their museums, in instructing the people, and in the general increase and diffusion of knowledge concerning their prehistoric ancestors and people.

The same story may be said with regard to Italy. Genoa, Pisa, Turin, Milan, Verona, Vicenza, Parma, Regio, Bologna, Imola, Marzabotta, Florence, Arretzo, Cortona, Perugia, Chiusi, Corneto, all possess extensive museums, and so down to Rome, where are to be found three or four great governmental establishments organized with presidents and professors, and approaching the dignity of institutes and colleges with museums attached, all devoted to the study of antiquities almost, if not quite, prehistoric.

This list might be extended indefinitely. Austria, Hungary, Pologna, Russia, are all interested in this new science and are devoting themselves to the spread of its knowledge and to the increase of their museums.

I have failed largely in the purpose if before this time I have not convinced the reader that the United States, both government and people, have not been aroused to an appreciation of this new science and have not attached to it the importance which it receives in other countries.

(*To be continued.*)

RECENT LITERATURE.

An American Book on Fungi.—A few months ago the botanists of the country were greatly pleased with the announcement that J. B. Ellis and B. M. Everhart, the well-known publishers of the "North American Fungi," would soon bring out a book on the Black Fungi (Pyrenomycetes) a group presenting many difficulties to the student and collector. Early in May the work was completed and sent out to subscribers. It is a thick volume of about 800 octavo pages, accompanied by forty-one excellent plates, the latter the work of the lamented F. W. Anderson.

It is unnecessary to say here that this book will be useful. It could not be otherwise. Even the possessor of Saccardo's "Sylloge" must have this American work, and no beginner can afford to do without it.

For the help of beginners a freer use of synopses would have been useful, and it is to be hoped that such will be prepared for future editions.

The descriptions are full, and spore measurements are quite generally given, with many critical notes. Some changes in nomenclature are made, the merits of which need not be discussed in the present notice. It is pleasant to notice that the exact method of citation of authorities is followed, the name of the author first publishing the species being retained in parenthesis in case of a removal of the species from the genus in which it was first placed. In this connection the authors significantly remark that "the piratical practice of omitting the first name and substituting the second in its place can not be too strongly condemned."—CHARLES E. BESSEY.

A Study of the Oak Tree.[1]—If the pretty volume by Prof. Marshall Ward, recently brought out by Appleton, finds readers enough to warrant author and publisher in bringing out others, English speaking botanists will have cause for congratulating themselves upon the progress of botanical science among the people. Here is a strictly scientific popular book, confidently put forth by the publisher, at no little expense. That it should be brought out at all is a most encouraging sign, especially as it is not written to fill "a long felt want," nor is it

[1]The Oak, a popular introduction to forest botany, by H. Marshall Ward, M. A., F. R. S., F. L. S., Professor of Botany at the Royal Indian Engineering College.

designed to be used as a text book in the schools. It appeals to that constantly increasing class of intelligent readers and students who are interested in natural objects, and who cultivate natural history in the same way and for the same purpose as others cultivate literature, history or music. This growth of the study of nature as a means of broader culture is a significant feature in modern life, and books like the one under consideration will do much to foster and encourage it.—Charles E. Bessey.

The Horse. A Study in Natural History.[1]—Mr. Flower's Study of the Horse is the second of the Modern Science Series, edited by Sir John Lubbock. The author, in his preface, refers to the number of works on horses and equitation, but offers as a reason for adding to their number the fact that knowledge has accumulated recently from various sources which enables the writer to treat the subject from the standpoint of an evolutionist.

The subject divides itself naturally into fossil and recent horses. The relations of each are discussed, and of the one to the other, so that the horse is shown, not as an isolated form, but as one term in a vast series.

The last two chapters are devoted to the structure of the horse. Since the anatomy has been so thoroughly worked out and so minutely described Prof. Flower has selected a few of the most important parts, describing them in language which may be understood by those who are not professional anatomists. Particular attention is given to the parts most specialized—viz., the teeth and limbs.

Prof. Flower is fortunate in having his book well illustrated by engravings from original photographs. That of the quagga is especially interesting as being from the only photograph known to have been taken of this animal in a living state.

Prof. Flower's account of the ancestry of the horse is in accordance with the latest paleontologic discoveries. He traces the line backward to Phenacodus, as is done by American paleontologists; but his suggestion that the European Hyracotherium is the same is not according to the evidence at present accessible as to the characters of the two genera. Prof. Owen's descriptions and figures of Hyracotherium sustain the view of Cope and Lydekker, that it is one of the Lophiodontidæ, and allied to Pliolophus.

[1]The Horse. A Study in Natural History, by William Henry Flower, London, 1891. Modern Science Series, edited by Sir John Lubbock.

The Fur of Animals.[2]—This volume forms one of a series on arts and trades, and the author has treated the subject from that point of view. He gives first the structure, form and coloration of the skins of those animals useful to man either for clothing or for furniture. To this is added a classification based on the uses to which the hides, hair, wool or fur is put. Following this technical part is a description of the animals mentioned, their haunts, the methods of hunting or trapping them, the principal markets and the prices paid for the pelts.

M. Lacroix–Dauliard has added much to the interest and value of his book by discussing the parasites that attack the skins, as well as those which injure the manufactured materials. The best known are the Dermestes, the Anthrenus, the Attagenus, the Teignes and the Acarians. Various ways of destroying these pests are mentioned, but the most effectual, in the author's judgment, is frequent exposure to light and air.

Eighty-nine well-shown figures illustrate the text and contribute much to the attractiveness of the book.

[2]Le Poil des Animaux et les Fourrures, Lacroix–Dauliard. Bibliothéque des Connaissances Utiles. Librarie J. B. Bailliére et Fils., 1892.

General Notes.

GEOLOGY AND PALEONTOLOGY.

The Mexican Meteorites.—Geologists are indebted to Mr. J. R. Eastman for a concise account of the Mexican meteorites. In a paper read before the Philosophical Society of Washington Jan. 2, 1892, he presented the latest and most complete information upon the subject, in a compact form convenient for reference. A list of the iron meteorites, with a table of their weights was given, followed by remarks as to the relative occurrence of iron and stony meteorites.

From the available data the ratio of weight of the former to the latter is as 1 to 12.23. The aggregate weight of meteoric iron observed and discovered to date on this continent is about 153 tons. If the above ratio is true in all cases there should have been a fall of about 1,880 tons of stony meteorites, or in all over 2,000 tons of meteoric matter precipitated upon the earth.

Mr. Eastman offers the following theory to account for the apparent excess of iron over stony meteorites: When a stony meteorite falls to the earth it generally breaks into many fragments, and the ruptured surfaces plainly indicate the nature of the catastrophe. The author knew of no case where an iron meteorite showed any indication of having been twisted, broken, or torn off from another mass of the same material.

The true type of meteorite which reaches the earth from outer space is probably like that which fell in Iowa county, Iowa, on Feb. 12, 1875. This meteorite is composed almost wholly of stony matter, but scattered through the mass are small grains of nickeliferous iron. This iron may exist in the stony matrix in all forms and sizes, from the microscopic nodule to the mass weighing several tons. When the stony mass comes in contact with the earth's atmosphere the impact breaks up the matrix, sets free the iron bodies and they reach the earth in the same condition, so far as mass and figure are concerned, as they exist in the original formation. In such cases it is probable that the stony portion of the original body is rent into such minute fragments by the explosion, that they would not reach the earth in any appreciable size. The larger the masses of iron the more complete would be the destruction of the original body, and the larger stony meteorites would be

those that contain the smaller granules of iron. (Phil. Soc. Washington, Bull. Vol. xii, pp. 39–52.)

On the Separation and Study of the Heavy Accessories of Rocks.—For the past few years Prof. Orville Derby, of the Geological Survey of Brazil, has employed the method of washing rock powder in water as the best means of isolating the accessory elements in rocks from the more abundant essential elements. His process differs from that of Cordier and Thurach in that he uses the batêa or Brazilian miner's pan instead of the glass or porcelain dishes of the laboratory.

The knack of washing is readily acquired, and the whole operation, from the preliminary crushing to the mounting of a microscopic slide, can be performed in a few minutes.

The delicacy of the process is well illustrated by the grouping of the minerals during the last stages of the washing. On throwing the sand out into a trail it will be found to be transversely streaked with different colors as the minerals arrange themselves according to their specific gravities. In a decomposed granite, for instance, the outer part will be white with quartz, then a reddish band of garnet, then a black band of titaniferous iron, and, finally (if magnetite be not present), a white band of zircon, or white and yellow if monazite is also present.

Prof. Derby's observations incline him to think that the use of the batêa will prove valuable in work which is more strictly geological, for the following reasons:

1st. Most of the prominent rock groups afford residues which are characteristic, either through the presence of accessories peculiar to each group, or by the relative abundance or peculiarities of form and structure of those that are common to several groups.

2d. Many of the most common heavy accessories are practically indestructible, and can therefore be recovered in recognizable form even when the rocks or their debris are so completely altered that their original type is not otherwise recognizable.

If rock types can be identified by their residues many rock masses can be taken into account which otherwise must be left out.

For purposes of identification only material decomposed *in situ* should be washed.

Prof. Derby also suggests that this method of study of the heavy accessories of rocks may be of value in investigating those rocks which have suffered alteration by metamorphism.

The kind and condition of a mineral constituent may be a means of distinguishing the metamorphosed eruptive from the metamorphosed sedimentary.

After discussing the subject in his usual comprehensive manner, Prof. Derby concludes that there is a reasonable probability that zircon, and to a less degree monazite, may prove to be guide minerals by which eruptives and their derivations can be certainly identified, no matter what degree of alteration they may have suffered. This probability gives additional interest to the study of the heavy residues of rocks which, it is hoped, will lead geologists to thoroughly test this hypothesis in other parts of the world. (Proceeds. Rochester Acad. Sci., Vol. i, pp. 198–206.)

A Section of the Strata at Rochester, New York.—A boring made by the firm of Otis & Gosline in a search for gas in the vicinity of Rochester, N. Y., has made known some interesting facts concerning the thickness of the rock strata of that region. The drill was sent to a depth in the rock of 3,078 feet, where the exceeding hardness of the rock made further progress very difficult. Small quantities of gas were found at various depths. A little brine was encountered at a depth of 1,330 feet.

From a carefully kept well record Prof. H. L. Fairchild has prepared the following condensed section of the Rochester well.

Altitude 484 feet above tide.

Horizon.	Thickness.	Kind of Rock.	Depth.
Niagara	156 ft.	Niagara limestone, Niagara shale, Clinton limestone	156 ft.
	22 ft.	Clinton upper green shale	
Clinton	15 ft.	Clinton (Pentham) limestone	
	35 ft.	Clinton lower green shale	228 ft.
Red Medina	1075 ft.	Red sandstones and shales	1303 ft.
	25 ft.	Blue shaly sandstone	
Oneida	45 ft.	Hard gray sandstone	
(Oswego)	13 ft.	Dark gray shaly sandstone	1386 ft.
Hudson and Utica	598 ft.	Dark shales	1984 ft.
Trenton	954 ft.	Dark limestone	2938 ft.
	10 ft.	Gray limestone	
	30 ft.	Drab limestone	
Calciferous?	50 ft.	Dark gray limestone with shale	
	44 ft.	Black magnesian limestone	
	3 ft.	Dark calcareous shale	3075 ft.
Algonkian?	2 ft.	White quartz sandstone	
or Archean?	1 ft.	Powdered ferruginous quartz	3078 ft.
	3078 ft.		

The fact that at the nearest exposures the calciferous lies directly upon crystalline rock is the author's reason for referring the last two doubtful rocks to the Algonkian or Archean. (Proceeds. Rochester Acad. Sci., Vol. i, p. 182.)

MINERALOGY AND PETROGRAPHY.[1]

The Eruptives of Cabo-de-Gata.—The eruptive rocks of the Cabo-de-Gata region in southeastern Spain are pumiceous, glassy and granular liparites, andesites, dacites and an occasional basanite. The liparites are rare as fragments in a liparitic tufa and as small dykes cutting the fragmental rocks. The dacites cover a large stretch of country. They are the most abundant types in the region, and are developed in great variety. Two principal groups are distinguished. The first is characterized by the abundance of its phenocrysts, among which are large hornblendes, and by the possession of augite and hypersthene. Augite occurs in their groundmass, quartz is scarce, and their feldspar is almost exclusively plagioclase. In the second group phenocrysts are less common. Biotite is the predominant colored constituent. Quartz and sanidine are both plentiful and the rock thus verges toward the liparites. All the components of these dacites have been very minutely described by Osann.[2] But few of them present special peculiarities. The most interesting features connected with them are the alteration of hornblende into pyroxene and the intergrowth of augite and bronzite, with the pinacoids and prisms of the two minerals parallel. The andesites, which are best developed in the southern and southeastern parts of the region, are hornblendic and biotitic varieties. A mica andesite from the Rambla del Esparto contains an enormous number of granular inclusions composed of cordierite (?) biotite, spinel, sillimanite, corundum, andalusite, plagioclase, rutile, zircon, garnet, quartz and apatite. They are regarded as having resulted from the metamorphism of blocks brought from below, and the crystallization of andesite components upon them. The spinel occurs in dark-green and grayish-red crystals, the former sometimes surrounding the latter. A dacite from Mazarron contains phenocrysts of cordierite,[3] whose prismatic crystals often reach a length of 1 cm. The forms

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2] Zeits. d. Deutsch. Geol. Ges. 1891, xliii, p. 688.

[3] Cf. American Naturalist, 1890, p. 69.

observed on them are ∞P, $\infty P\breve{\infty}$, $\infty P\bar{\infty}$, oP, P, and $\frac{1}{2}P$. In the neighborhood of ore veins the mineral is changed into pinite.

A Melilite Rock from North America.—From the bed of the Ottawa River, near Ste. Anne, not far from Montreal, Can., Mr. Adams[4] has obtained the first melilite rock described from North America. It occurs as a dyke in Potsdam conglomerate. The rock, which has a fine-grained, dark groundmass, often contains phenocrysts of green and red olivine, biotite and pyroxene. The matrix in which these lie consists of small biotites, olivines and pyroxenes, between which lies a still finer aggregate of melilite, pyroxene needles and a small quantity of a colorless mineral that may be nepheline. Perofskite, apatite and magnetite are also present in it. The brown biotite is an anomite, with a small biaxial angle. It consists of an interior inclusion-free nucleus, usually with a rounded outline, surrounded by a zone filled with augite microlites and bounded by crystal faces. The olivine contains but little iron (12.65%). The red color of some grains is due to inclusions of iron oxide. Its alteration is sometimes into serpentine, but more frequently into ferriferous magnesite and breunerite, whose composition is $MgCO_3$ = 64.83; $FeCO_3$ = 26.16; $CaCO_3$ = 1.66; impurities = 7.35. The alteration begins along cleavage cracks and proceeds inward from the peripheries of the olivine grains. The pyroxene phenocrysts are colorless and have an extinction of 42°. Like the biotite the augite grains are also bordered by a zone of a light brown color, which is of the same substance as that of the smaller phenocrysts and of the needles in the groundmass. The extinction in the zone is often 16° greater than that of the nucleus. The characteristic mineral of the rock, the melilite, possesses the peg structure and all the other peculiarities of this component of the Alnö specimens. Basal sections have rectangular or octagonal outlines, while prismatic sections are often flattened parallel to oP. The rock differs from the type alnoite in possessing no feldspar. The author thinks it is connected in some way with the Montreal volcanic center, forming Mt. Royal, which, as is well known, consists largely of eleolite syenites and related rocks. The composition of the rock follows:

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	Co_2, H_2O
35.91	.23	11.51	2.35	5.38	13.57	17.54	2.87	1.75	9.40

The Sanidinite Bombs of Menet and Monac.—The sanidinite bombs included in the trachytes of Menet, Cantal and of Monac,

[4] Amer. Jour. Sci., April, 1892, p. 269.

Haute-Loire, France, contain many interesting minerals, short descriptions of which are given by Lacroix.[5] In those from the first-named locality are vitreous orthoclase, anorthite microperthite, zircon in brilliant, transparent, wine-red and in colorless or brown and light rose crystals, sphene, apatite, corundum and biotite. The last named mineral is an original component of the rock yielding the bomb, while the zircon, sphene and apatite are certainly new products. The Monac sanidinites differ from those of Menet principally in being saturated with secondary substances.

Igneous Rocks from Montana.—Among the rocks found in the mountains of Montana and described by Lindgren[6] are dacite, trachytes, basalts and augite-syenites. One variety of basalt consists of fresh olivine, augite and analcite in a groundmass composed of magnetite, apatite andanalcites of a second generation. The rock was described in one of the Tenth Census Reports, where the analcite was stated to be in all probability an alteration product of nosean. The author now regards the mineral as unquestionably original.

Petrographical News.—Mr. Cole[7] describes a section of devitrified perlitic obsidian from Rocche Rosse, Lipari, in which the rock is much shattered. Around the fragments of glass thus formed spherulitic substance has resulted from the devitrification of their material. Beginning at the cracks separating the fragments the devitrification has progressed inward until a spherulitic zone now surrounds each piece of glass.——The mica schist[8] around the granite of the Schneekoppe in the Riesengebirge, Silesia, has been changed by the eruptive from a muscovite-garnet-quartz-schist to a schistose aggregate of quartz, muscovite, biotite, andalusite, and new, blood-red garnets. The biotite is in isolated small plates that are quite different in character from the flakes of muscovite adhering to the quartz grains in the original rock.——A few augite, saussurite and quartz diorites, a gabbro and several porphyries, porphyrites and diabases from the hills surrounding the Muir Glacier, in Alaska, are briefly described by Williams[9] in an appendix to Reid's account of the glacier.——In the olivine diabase of a dyke cutting the Sioux quartzite, in Minnehaha Co.,

[5] Bull. Soc. Min. d. Fr., xiv, 1892, p. 314.

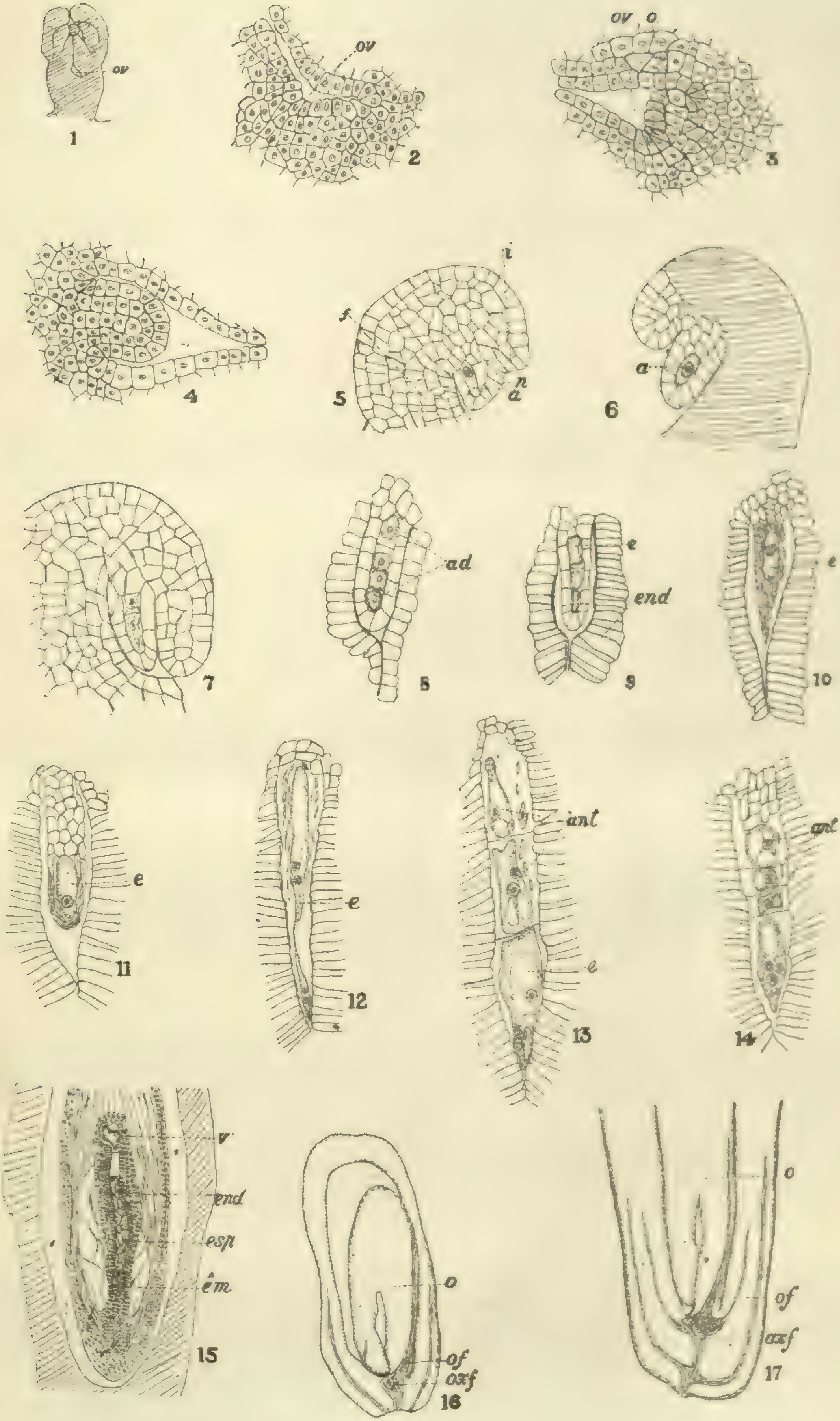
[6] Proc. Cal. Acad. Sci., 2, vol. iii, p. 39.

[7] Mineralogical Magazine, ix, p. 272.

[8] Zeits. d. Deutsch. Geol. Ges. xliii, 1891, p. 730.

[9] Nat. Geog. Mag., Washington, iv, p. 63.

PLATE XX.



Norris, on *Grindelia.*

S. Dak., Messrs. Culver[10] and Hobbs find that the reddish to yellowish-brown diallage is strongly pleochroic.

Mineralogical News.—*General Crystallographic.*—Wyrouboff, in the continuation of his crystallographic study of closely related double salts of sulphuric, selenic and chromic acids, has reached some exceedingly interesting results bearing upon isomorphism. After carefully measuring the crystals of ten of these compounds and comparing their optical properties, he finds that while several of them are crystallographically similar these same compounds possess quite different optical characteristics. $Fe\ K_2(SO_4)_2$, $Mn\ K_2(SO_4)_2$ and $Mn\ K_2(SeO_4)_2$ are optically as well as morphologically similar. Since the optical properties of crystals change when they are subjected to changes of temperature it follows that these properties are dependent upon the arrangement of the molecules—upon the character of the crystal network. Isomorphous bodies are those that possess identical networks, consequently isomorphous bodies are those that are similar morphologically and at the same time optically, and in which the changes suffered under similarly changed conditions are similar. The magnesian sulphates with seven molecules of water are good examples of a truly isomorphous group. There is another kind of isomorphism embracing those bodies in which the morphological properties are similar but the optical ones different. In such bodies, since the arrangements of the molecules in the two intermingled substances are different, there should be evidence in these of optical anomalies, which are not apparent in the simple compounds, and this is found frequently to be the case. A further conclusion drawn by the author from his experiments is to the effect that while in general, substances whose chemical composition is analogous have similar crystalline forms, it does not necessarily follow that isomorphous bodies possess analogous compositions; they need merely to be built upon the same plan, possess identically arranged networks. Many of the views put forth in the paper are novel, and some of them are rather startling. We shall look forward with much interest to their discussion by German mineralogists.——The relation between symmetry and the chemical composition of crystals continues to attract the attention of mineralogists theoretically inclined. Fock[11] now suggests that the method by which the problem is to be attacked is through the aid of stereochemistry. He assumes that the crystal particles have the same symmetry as the crystal individual, and seeks

[10]Trans. Wis. Acad. Sci., viii, 1891, p. 206.

[11]Zeits. f. Kryst., xx, p. 76.

to trace the symmetry of the particle to the symmetry of the chemical molecule as its source. According to the conception of most chemists the carbon atom may be represented by a point with four bars extending toward the four corners of a circumscribed tetrahedron. The symmetry of the carbon molecule is thus comparable with the symmetry of the crystallized carbon—diamond. With this suggestion as a basis the author shows how the crystallization of graphite and of some of the carbonates may be explained, but at the same time he confesses that few practical results can follow from the suggestion until we know more about the composition of solid substances.

Notes.—An attempt to discover the reason for the variation in the pyramidal angles of *arsenopyrite* and to settle its composition has been made by Weibull,[12] who has examined crystals from Silfberg, Delane, and other localities in Sweden, and from the well-known occurrences in Europe. Among the Silfberg crystals three types were recognized, on the first of which the predominant forms are ∞ P and $P\breve{\infty}$. Their axial ratio is .6841 : 1 : 1.1910, and composition (Fe Co Ni) $(S\ As)_2$. On the second type the same forms are observed with the addition of $\frac{1}{2}P\breve{\infty}$, but the crystals are usually prismatic parallel to $\breve{a}$. Their axial ratio is .6830 : 1 : 1.1923 and composition Fe S As. Crystals of the third type are long prismatic in the direction of *c* and are bounded by the same planes as are found in the second type. Their axial ratio is .6724 : 1 : 1.1896. Crystals from other localities show differences in composition and in axial ratio, and these differences are expressed in differences in habit. The formula best representing the composition of the mineral is thought to be $Fe(S\ As)_2$, and variations from it are thought to be due to inclusions in the material analyzed. If $Fe(As\ S)_2$ be considered the normal arsenopyrite ten per cent. of $Fe\ S_2$ may be replaced by $Fe\ As_2$, or the reverse, and the replacement will affect the axial ratio to a noticeable extent, an increase in $Fe\ S_2$ tending to increase the lengths of *a* and *c*. The substitution of Co and Ni for Fe affects the axes in the same way.——In an exhaustive article on the mineral deposits of Leogang in Salzburg, Buckrucker[13] gives a brief account of the region and a detailed description of the many minerals occurring therein. Thirty-two distinct species are referred to in the article, some briefly, others very extensively. Among the latter are *dolomite, aragonite, strontianite* and *celestite.* $2\ E_{Na}$ for aragonite is 30° 43.5′. $2\ V_{Na}$ for strontianite is 6° 59′ 12″

[12]Ib., p. 1.

[13]Zeits. f. Kryst. xix, p. 113.

and 2 E_{Na} for celestite is 87° 40′ 20″.——Mügge[14] has made an interesting study of quartz crystals imbedded in eruptive rocks. These were isolated by treatment of thin slices of the rocks with HF, and the etched figures produced upon them by the reagent were investigated. Of 888 individuals examined 382 were found to be simple, 506 twins of either right or left handed crystals, and 12 twins of right and left crystals. Pyrogenous quartzes like those deposited from solution are thus found to be more common in twinned than in simple forms. ——Lacroix[15] contributes a few notes on French minerals, especially those from the Central Plateau. He finds *leucite* forming veins in the basalt of Mt. Doré, with peripheral bands of feldspar. *Christianite* crystals imbedded in calcite occur in calcified inclusions in a basalt dyke at Montaudoux, Puy-de-Dôm. The same mineral is in the sanidinite bombs of Monac, and is associated with chabasite at Araules in the Haute-Loire. *Mesotype, analcite, zircon, sphene, vivianite, molybdenite, kermesite* and *pyrite* are the other minerals mentioned in the article.——Schrauf[16] describes the *metacinnabarite* crystals of Idria, Austria, and discusses their origin as well as that of the associated mercury and cinnabar. The crystals have a density of 7.66. They form the outer coating of spherules that within are massive metacinnabarite. Their crystallization is regular and habit dodecahedral.——Pearce[17] calls attention to the existence of tellurium and bismuth in nearly all the sulphides of the Leadville region.——Hills[18] recently exhibited to the Colorado Scientific Society pseudomorphs of malachite after azurite on which are implanted crystals of a second generation of the last named mineral with the same orientation as the original azurite.——Lacroix and Baret[19] find *bertrandite* at Mercerie in the Commune of La Chapelle-sur-Erdre, France. Its crystals are elongated parallel to the base, and are associated with orthoclase, albite, quartz and apatite in a granite.——The supposed sulph-antimonite of nickel, *korynite*, from Siegen, according to an analysis made by Laspeyres and Busz,[20] is a normal ullmanite, whose composition is:

[14] Neues. Jahrb. f. Min., etc., 1892, i, p. 1.

[15] Bull. Soc. Franç. d. Min., xiv, p. 318.

[16] Jahrb. d. k. k. geol. Reichsanst., 1891, xli, p. 349.

[17] Proc. Col. Sci. Soc. 1890, iii, p. 257.

[18] Ib., p. 258.

[19] Bull. Soc. Franç. d. Min., xiv, p. 189.

[20] Zeits. f. Kryst., xix, 1891, p. 8.

S	Sb	As	Bi	Fe	Co	Ni	Sp. Gr.
16.22	42.93	10.28	.68	.40	1.13	28.91	6.488

——A rose-red *tourmaline*[21] from Urulga, Siberia, has a composition corresponding to the formula 12 SiO_2, 8 Al_2O_3, 3 B_2O_3, 2(FeO MnO), Na_2O(K_2O Li_2O), 3 H_2O.——Genth[22] has revised Kerr's report on the minerals of North Carolina, and has published the amended and enlarged revision as a Bulletin of the Survey. All the minerals known to occur within the State are mentioned and described briefly, and a synopsis of the mineral wealth of the different counties is given in tabular form.——The sixth part of Hintze's Handbuch der Mineralogie has recently appeared. It discusses serpentine, nepheline, kaolin, sodalite, cordierite and related minerals.——A series of new measurements of *wollastonite*[24] crystals from Vesuvius adds considerable to our accurate knowledge of their morphological characteristics.

[21]Stchusseff. Ib., xx, p. 93.

[22]Bull. U. S. Geol. Survey No. 74, Wash., 1891.

[23]Zeits. f. Kryst., xix, p. 604.

BOTANY.

Development of the Ovule in Grindelia squarrosa.—The ovule in *Grindelia* arises by tangential division of the cells of the first, second and perhaps third hypodermal layers, resulting in an up-pushing of the floor of the ovarian cavity (figs. 1–4). As Coulter[1] says of *Taraxacum*, the ovule does not appear exactly at the bottom of the cavity of the ovary, but a little at one side. The ovule springs from the axis of the flower as is shown by the passing of the fibrovascular bundle directly from the axis to the funiculus. In this respect *Grindelia* agrees with *Helianthus* (figs. 16 and 17) and differs from *Taraxacum* in which, according to Coulter, the fibrovascular threads of the funiculus come from a carpellary branch of the axis. The young ovule early begins to curve upon itself, the single integument appears on the upper convex surface and, by growth beyond and around, completely enwraps the apex of the ovule, the nucellus (figs. 5–7). At this time we distinguish three portions of the ovule—funiculus, integument and nucellus. The nucellus consists of an axial row of cells covered by the epidermis. In the apex of the nucellus, immediately beneath the epidermis, is the archesporium (figs. 5 and 6). This divides into two and then four cells (figs. 7 and 8). By accelerated growth the most deeply situated of these cells absorbs or pushes the others toward the apex of the nucellus and becomes the embryo-sac (figs. 9–11). At the same time the epidermis of the nucellus shrinks and disappears. Concomitant with the degeneration of the nucellar epidermis the adjacent layer of the integument becomes greatly modified, forming what Hegelmaier[2] terms the "Endodermis." Its cells lengthen radially, and the cell walls become much thickened and resistant to the section knife. Of the stages between the embryo-sac with but one nucleus and the mature state of the same I have found few representatives. Enough was seen, however, to indicate that the typical order is followed (figs. 12–14). The nucleus undergoes a three-fold division. A tetrad is seen in the micropylar end. The usual number of the antipódal cells is two (fig. 13), though rarely a third is seen (fig. 14). They are situated in a linear series with the embryo-sac, being early

[1]Development of a Dandelion Flower, AMERICAN NATURALIST, Vol. xvii, No. 12, Dec., 1883.

[2]Über den Keimsack einigen Compositen und dessen Umhüllung. Bot. Zeitung. Nos. 50–52, 1889.

marked off from the latter by distinct cell walls. They persist for some time after fecundation, and as in *Helianthus*, send out vermiform protoplasmic extensions that assist in tearing down the adjacent tissues. Shortly prior to fecundation the tissue just outside the endodermis begins to degenerate by losing its protoplasmic contents. With the development of the endosperm and the growth of the embryo, this absorption of the tissue of the ovule proceeds to such an extent that, as Hegelmaier[3] notes in *Helianthus*, the endodermis, with its contents, can be removed with ease. While this is going on the one-layered endodermis has become many layered except at its micropylar and antipodal ends (fig. 15). Its cells become rich in protoplasm at the expense of the surrounding tissue now rapidly becoming depauperate. The suggestion of Hegelmaier that this condition in *Helianthus* may be due to cultivation, etc., is of little value, since the same condition occurs in *Grindelia* and also in uncultivated *Helianthus*. Later, as the seed matures, the endodermis as such disappears, being represented only as a thin, compressed coat of the embryo.

It is thus seen that the development of *Grindelia* agrees closely with that of *Senecio* described by Warming[4] and Vesque,[5] though the latter of course was considerably in error. *Conyza*, described by Guignard[6] has a similar development, but the antipodal cells are more numerous than in *Grindelia*. *Helianthus*, studied by Hofmeister,[7] and later by Hegelmaier,[8] agrees very closely with *Grindelia*. As in *Helianthus* the endodermis is strongly developed, in marked contrast to *Ageratum* where it is scarcely differentiated. Hegelmaier observes in the mature embryo-sac of *Senecio* five nuclei: the two synergidæ, the oösphere, and two secondary nuclei of the embryo-sac. The same is seen in *Grindelia*.

In a short notice of this kind, for the most part merely confirmatory of similar studies of others, it seems hardly worth the while to

[3]Loc. cit.

[4]De l'Ovule. Ann. Sc. Nat. 6, Sér. v. 1878, p. 176.

[5]Développement du sac embryonnaire des Phanérogames, Ann. Sc. Nat. 6 sér., vi, 1878, p. 237. Nouvelles recherches sur le développement du sac embryonnaire des végétaux phanérogames angiospermes. Ann. Sc. Nat. 6 sér., viii, 1879, p. 261.

[6]Recherches sur le sac embryonnaire des Phanérogames. angiospermes. Ann. Sc. Nat. 6 sèr.. xiii, 1882, p. 136.

[7]Entstehung des Embryo. Leipzig, 1849,

Neuere Beobachtungen über Embryobildung der Phanerögamen. Pringsheim's Jahrbücher, i, 1858, p. 82.

[8]Loc. cit.

attempt to give titles of even the most important of the literature on the subject.—H. W. NORRIS, Grinnell, Iowa.

EXPLANATION OF FIGURES, PLATE XX.

Abbreviations used.

a, archesporium; *ad*, daughter cells of archesporium; *ant*, antipodal cells; *axf*, fibrovascular bundles of the axis of the flower; *e*, embryo-sac; *em*, embryo; *end*, "endodermis;" *esp*, endosperm; *f*, funiculus; *i*, integument; *n*, nucellus; *o*, ovule, *of*, fibrovascular bundle of ovule; *ov*, cavity of ovary; *v*, part of vermiform extension of protoplasm of an antipodal cell.

Figs. 1–16 are of *Grindelia squarrosa*.

Fig. 17 is of *Helianthus annuus*.

ZOOLOGY.

Notes on a Nematode Parasite from the Chipping Sparrow (*Spizilla socialis*).—I have received from Mr. Wm. B. Marshall, Albany, N. Y., a parasite from the thoracic cavity of the chipping sparrow which appears to be new.

FIG. 1.

The sparrow was shot by Mr. Marshall on May 14, 1892, and the worm was found lying directly against the heart of the bird. The color of the worm while alive was a brilliant red. It is a male; the head is damaged but otherwise the specimen is perfect.

Although the diameter of this specimen is proportionally many times greater than that of any recorded species of *Trichosoma*, the body being not at all hair-like; and although the posterior spicule and its sheath present some difficulties when compared with descriptions of the various species of *Trichosoma* and the related genus *Trichocephalus*, I prefer to refer the specimen to the former genus, to which it is certainly closely allied, rather than to erect a new genus for its accommodation. I therefore place the specimen provisionally in the genus *Trichosoma* and propose the name *Trichosoma rubrum* for it.

The specimen has the following characters: Body cylindrical, with somewhat yielding walls, and presenting three distinct regions; an

anterior region, slender and containing the œsophagus; a thicker median region, containing the dark-brown intestine and the convoluted generative tube; a posterior slender region sharply marked off from the median region by a constriction, containing the uncolored posterior portion of the intestine and the posterior portion of the generative tube. The latter region terminates in an enlarged and gibbous copulatory bursa, which is denticulate with about two rows of blunt teeth on its rim, and contains a single, club-shaped spicule. The anterior and median regions are smooth or with faint longitudinal striations; the posterior region is transversely wrinkled.

Fig. 2.

The œsophagus is straight, slender and communicates by a rounded base with the intestine, which is broader than the œsophagus, abruptly truncate at its origin and continues of nearly uniform size throughout the median portion of the body. The walls of the intestine in the median region of the body were seen to contain polygonal, mostly hexagonal, cells [Fig. 5]. The intestine loses its dark-brown color as it passes from the median to the posterior region of the body. The anal aperture is at the base of the copulatory bursa [*a*, Fig. 3]. The generative apparatus is a single tube which extends from the anterior end of the intestine to the copulatory bursa, where it opens beside the papillary termination of the intestine, [*vd*, Fig. 3]. In the central region of the body it is much convoluted; in the posterior region of the body it is nearly straight and thick-walled.

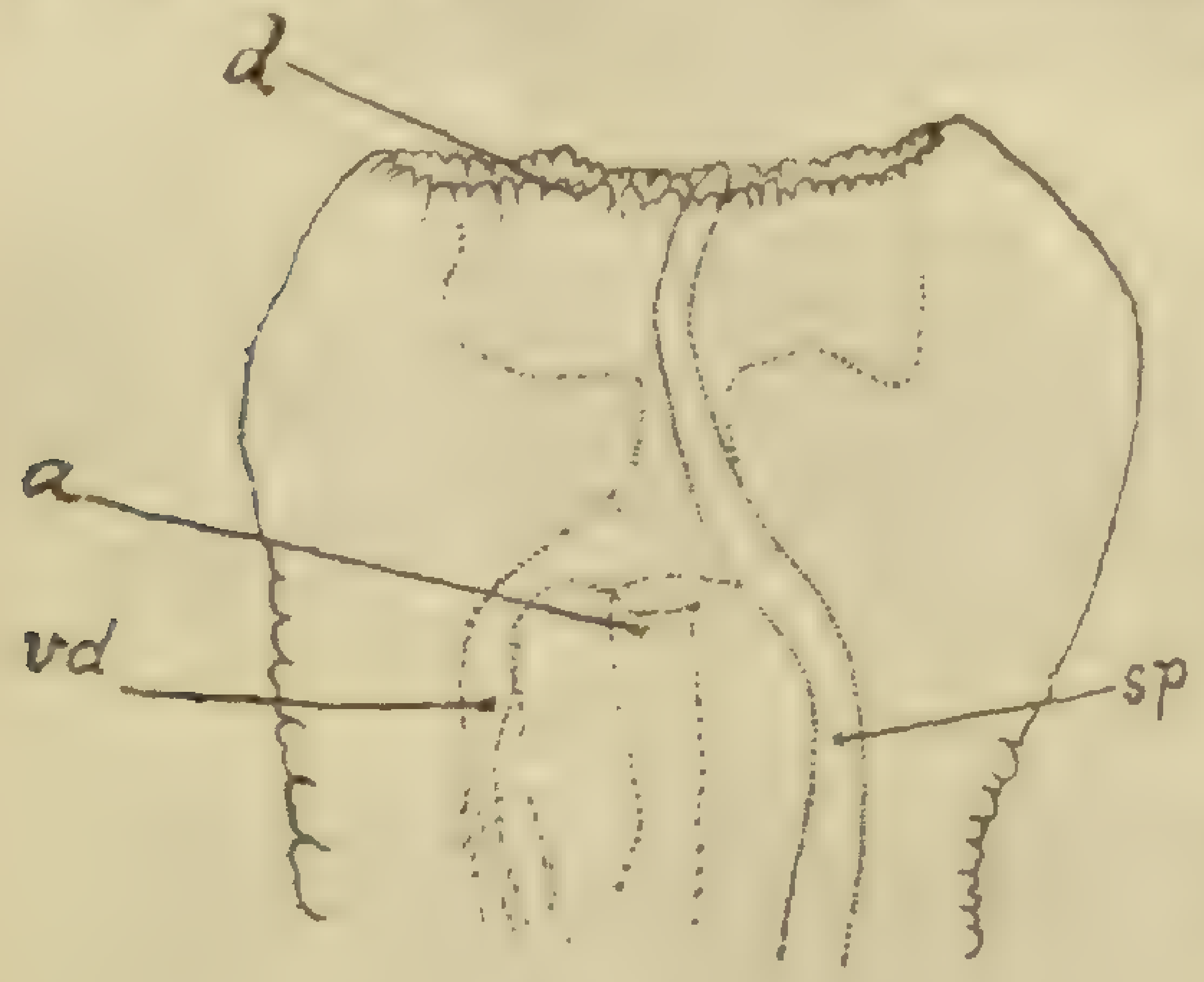


Fig. 3.

The spicule [Figs. 2, 3, 4], is club-shaped, somewhat spiral in its middle portion, about twice the length of the bursa and less than one-fifth the length of the posterior division of the body.

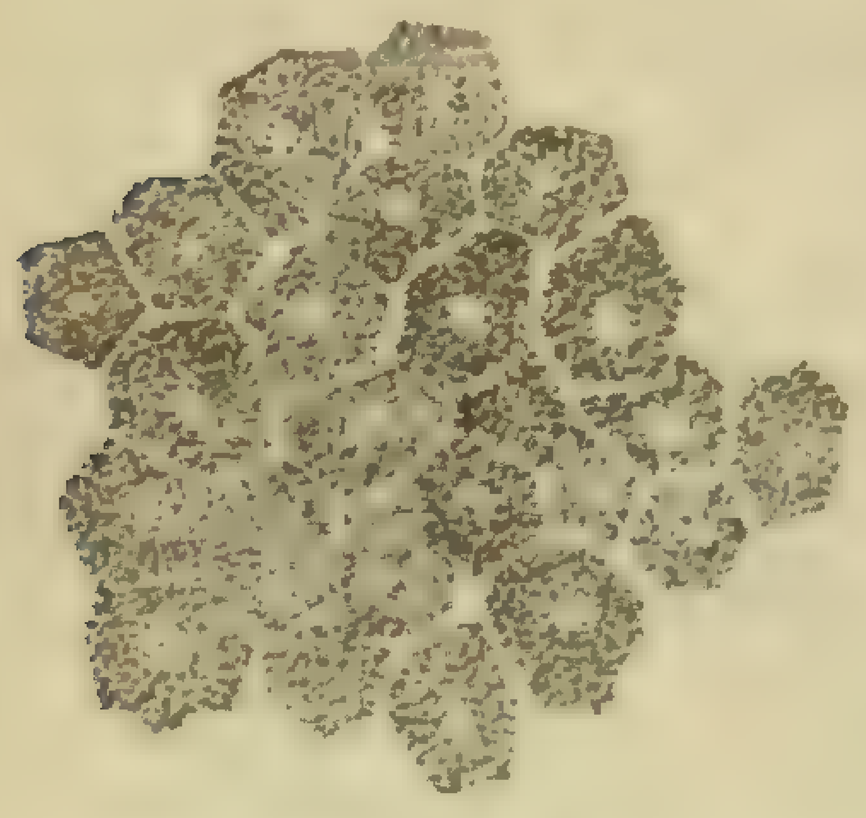


Fig. 5.

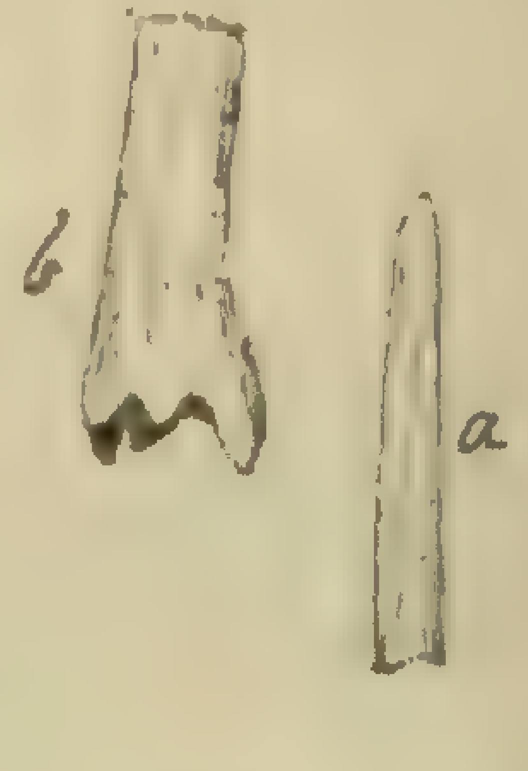


Fig. 4.

The following measurements were made on the specimen in acetic acid:

	Millimeters.
Length	25.00
Length of anterior division or neck	2.20
Length of median division, body proper	17.30
Length of posterior division	5.50
Diameter, median	0.90
Diameter, anterior end	0.42
Diameter, 1mm. from anterior end	0.32
Diameter of bursa	0.36
Length of spicule	0.42
Diameter of spicule, apex	0.01
Diameter of spicule, middle	0.015
Diameter of spicule, base	0.04

The anterior division of the body or neck passes by rather abrupt enlargement into the body proper. The diameter of the œsophagus at base is 0.18 mm; and the breadth of the intestine at its anterior end is 0.3 mm.

The posterior, transversely-wrinkled portion may, possibly, be retractile, although the appearance is against this supposition.

The single specimen, upon which this description is based, is in the possession of Mr. Wm. B. Marshall, State Museum, Albany, N. Y.

EXPLANATION OF FIGURES.

Fig. 1. Specimen, head missing, x 6. *a*, neck; *b*, body; *c*, posterior region of body separated from body proper by a constriction; *p*, œsophagus; *i*, intestine; *t*, reproductive tube.

Fig. 2. Bursa and spicule, x 75.

Fig. 3. Bursa, optical section, x 150, *a*, anal aperture; *d*, denticulate rim; *sp*, spicule; *vd*, termination of reproductive tube.

Fig. 4. Portions of spicule, x 200, *a*, apical, and *b*, basal portions.

Fig. 5. Polygonal cells in wall of dark-brown portion of intestine, x about 150.

EDWIN LINTON, PH. D.
Washington and Jefferson College.

Washington, Pa., June 1, 1892.

EMBRYOLOGY.[1]

The Development of Paludina vivapara.[2]—R. von Erlanger contributes two papers on this subject which form a comprehensive and valuable study of the development of this species. He describes concisely and clearly the development of the tissues and organs, giving special attention to the origin of the mesoderm and to the formation of the pericardium, heart, primitive kidneys, permanent kidneys, renal ducts, reproductive organs, and nervous system. The author had an abundance of material and believes he was able to fully verify all his results. Heretofore no one has succeeded in keeping alive the embryos after removing them from the opaque albuminous capsule which encloses them. The author found they would live for a time in a solution of 20cc. of egg albumen, 1g. of common salt and 200cc. of water; so that he was able to observe the processes of development in the living embryo. Of the fixing agents used Kleinenberg's picro sulphuric acid with a drop of 5% osmic acid added was by far the most successful.

The mesoderm arises from the archenteron at the time of the formation of the velum. The ventral wall of the archenteron pushes out as a single large sac, which soon pinches off from the rest of the entoderm. For a time it has the form of a closed vesicle lying in the ventral half of the embryo between the ectoderm and entoderm. This vesicle enlarges, its cells becoming somewhat flattened in the process. Later the walls of the vesicle break up into their constituent cells, the disintegration beginning at the mid-ventral point of the vesicle. Some of the cells apply themselves to the ectoderm (somatopleure), some to the entoderm (splanchnopleure), others, star shaped, form an extensive net-work filling the segmentation cavity; processes from the somatopleuric and splanchnopleuric mesoderm cells also join the net-work. The different organs now begin to make their appearance. The coelom of Paludina, according to this description, arises as a single, median, ventral evagination from the archenteron.

At the time when the rudiment of the stomadæal invagination appears there can be seen in the posterior part of the embryo, below

[1]This department is edited by Dr. E. A. Andrews, Johns Hopkins University.

[2]Zur Entwicklung der Paludina vivapara. R. von Erlanger, Morph. Jahrb., vol. xvii, 1891; Part I, August; Part II, October.

the ventral wall of the gut, a paired mass of spindle-shaped mesoderm cells (each half of this mass of cells contains a cavity). This is the rudiment of the pericardium. It varies greatly in different individuals, but always has a paired origin. The two halves fuse later, but for a considerable time there remains a septum between the cavities of the two sides. The right cavity is from the first the larger of the two. Erlanger says: "I was not able in Paludina to see the immediate transformation of the coelom into the pericardium, since the whole secondary body cavity is so early wholly filled with irregularly disposed, spindle-shaped mesoderm cells; yet the rudiment of the pericardium is formed between the two mesoderm layers, one of which clothes the inner surface of the ectoderm, the other the outer surface of the gut.

"The question then arises whether the pericardium represents the whole secondary body cavity (which would be greatly reduced) or merely a part of it, so that then the rest of the coelom would coincide with the primary body cavity or segmentation cavity. I now incline toward the second view, and think that the coelom only partially persists as such in the pericardium, while by far the greater part of it is obscured by the spindle-cells which fill it and so simulates the primary body cavity [—und daher sich mit der primären Leibeshöhle deckt]. The development of Paludina, described in this paper, appears to me to uphold this conclusion, and my other not yet completed researches in regard to the manner of formation of the blood-vessels strengthens me in this view."

The kidneys arise as evaginations, right and left, of the pericardial wall, while the embryo is still untwisted. They are first indicated by thickened areas of this wall. These thickened areas push out toward the mouth chamber until they assume a tubular form. The rudiments of the renal ducts arise at the same time with the latter, as evaginations, right and left of the walls of the mantle chamber, toward the rudiments of the kidneys. The right kidney rudiment and the rudiment of the right renal duct unite to form the permanent kidney. The left kidney is never fully formed, its rudiment never uniting with that of the left renal duct. Each of these persist for a time, but during the subsequent spiral twisting of the embryo each is obliterated. The secretory portion of the kidney arises then, from mesoderm and not from ectoderm, as has been claimed. Its excretory duct arises from the ectoderm of the mantle chamber.

The heart arises as an invagination of the dorsal area of the pericardium, forming an antero-posterior furrow. Soon this furrow con-

stricts in the middle, indicating the line of demarkation between auricle and ventricle. The heart furrow sinks more and more into the pericardial sac until it becomes a closed tube distinct from the latter, except at its two openings, one on the originally anterior, the other on the originally posterior face of the pericardium. At the same time the heart has divided into an auricle (posterior) and a ventricle (anterior), as was before indicated by the constriction in the heart furrow.

By the twisting of the body of the embryo the heart is brought upon the left side and the kidney to the middle line. The kidney grows larger, its opening into the pericardium becomes narrower, and the external orifice of the renal duct grows smaller and smaller. At the same time the cells of the wall of the kidney enlarge and in different places the walls push into the lumen of the gland, forming strands which by further development are converted into a mass of spongy tissue. The kidney, then, is not a typical acinous gland.

The primitive kidneys (" Urnieren ") arise from mesoderm, one on each side of the embryo, just behind the velum. They first appear at the time of the stomadæal invagination, while the embryo is still wholly symmetrical. Each rudiment is at first a solid mass of cells. Soon a cavity appears within the mass, and at the same time it approaches the surface. It soon breaks through the ectoderm cells to the surface. Its cells can be distinguished from the ectoderm and the rest of the mesoderm by their large size, clear protoplasm and deeper staining. It is still a closed vesicle. Now it elongates, becoming tubular, and soon it gains an external opening. There is no internal opening for the primitive kidney. Its inner end is formed by a mass of spindle-shaped and star-shaped mesoderm cells, at least one of which bears long cilia, which are active in the living embryo. No concretions or excretory granules are present. In the absence of any internal opening the primitive kidney of Paludina resembles the excretory organs of Plathelminths, " yet it may be possible that this departure from the ordinary condition is only the result of a certain degeneration." Erlanger thinks that in the pair of primitive kidneys and the pair of permanent kidneys (only one of which fully develops) we may have represented the segmental organs of two segments, comparable to the segmental organs of the worms.

The author shows that each of the ganglia of the nervous system arises by a sort of delamination from thickened areas of the ectoderm. All but the visceral ganglion arise from paired rudiments. The vis-

ceral ganglion arises from a single thickening of the wall of the mantle chamber near the pericardium.

There is no "Scheitelplatte," the two rudiments of the cerebral ganglia being from the first distinct. They arise by delamination from two distinct thickenings of the ectoderm of the pre-velar area, situated one on the right, one on the left of the centre of the area.

The pedal ganglia next appear, arising in the same way by delamination from two distinct ectodermal thickenings. The pallial ganglia develop from similar paired rudiments. The buccal ganglia are formed later from paired thickenings of the ectoderm of the ventral wall of the stomodæum. Two thickenings of the anterior border of the mantle give rise to the two intestinal ganglia, which are at first right and left. The twisting of the embryo soon brings the right one above the intestine (supraintestinal ganglion) and the left one below (subintestinal ganglion). The subintestinal ganglion does not appear in the adult. The visceral ganglion is formed from the posterior part of the floor of the mantle chamber. It arises from the ectoderm, but does not have a paired origin, differing in this respect from all the other ganglia.

As seen in the order of description, the ganglia arises progressively from before backward. The commissures and connectives arise in the same order. The cerebral ganglia first connect with each other, then with the pallial, the pedal and the buccal ganglia. The pedal ganglia next unite and then the buccal ganglia. No commissure connects the pallial ganglia. Of all the connectives between the cerebral ganglia and the other nerve centres the cerebro-pedal connectives are the last to appear. This is the only exception to the rule that the nervous system develops progressively from before backward. Because of the small size of the ganglion cells Erlanger was unable to demonstrate the origin of the nerve fibres.

"The circulatory system of Paludina arises in the manner typical for the Mollusca."

The origin of the sexual organs is interesting. It is the same in both sexes. The ovary, or testis, is formed from an evagination of a portion of the pericardium, almost, or exactly, in the place where earlier the rudimentary left kidney was formed. The duct arises as did the rudimentary left renal duct and from the same region of the mantle chamber. The tubular rudiment of the "sexual gland" separates from the pericardium and forms a hollow vesicle, which, later, connects with the sexual duct. The sexual organs are formed, then, apparently by the reopening of the left kidney, which appeared and

atrophied at an earlier stage in the development. This manner of development, though peculiar, corresponds fundamentally to the Molluscan type. The renal ducts probably originally served as sexual ducts also (e. g. Chiton). In Paludina we have, associated with the twisting of the body, a differentiation in function, by which the right uro-genital duct comes to serve simply as a renal organ and the left as a sexual organ.

Among the most valuable features of this paper is the review of the literature of the subject. The author's discussion of the relationship of the Mollusca to the annelids and flat worms is not so important. Many points in the paper and some whole sections (e. g. the development of the sense organs) have been passed over in this brief review. I trust, however, that reference has been made to the points of special interest, and such points are not few. The author's clearness and conciseness of statement make his paper a very readable one.—MAYNARD M. METCALF.

ENTOMOLOGY.

Classification of the Mites.—A paper of much value to students of the Acaroidea has recently been published[1] by Dr. Trouessart. It is entitled "Considérations générales sur la classification des acariens, Suivies d' un essai de classification nouvelles." The author first gives a historical sketch of the classifications that have been proposed for the group, from that of Latreille in 1795 to that of Canestrini in 1891. He then discusses the characters upon which the classification should be based, gives the tabular statement of his new classification (translated on the following page) and concludes with a useful review of the families, subfamilies and genera, with the characters of the families and subfamilies. Dr. Trouessart thinks the mites should form the sub-class Acaroidea, of the class Arachnida, and divides them into two orders, the Acarina and the Vermiformia.—C. M. W.

Color Preferences of the Carpet Beetle.—During the past May the Buffalo carpet beetles (*Anthrenus scrophulariæ*) have been abundant on the tulip beds at Hanover, N. H., taking advantage, no doubt, of the open windows of the house-cleaning period to fly out and get some pollen for food. In a small bed containing about three dozen tulips, three-fourths of which were of red colors, and the rest of white and

[1]Revue des Sciences Naturelles, 1892.

Sub-class	Orders.	Sub-orders.		Families.	Sub-families.
Sub-class Acaroidea.	Order I. **Acarina.** Abdomen entirely united with cephalothorax.	A. Tracheæ opening on anterior portion of body (rostrum or thorax). **Prostigmata.** Atrophied in aquatic types. Body having epimera below.	Palpi free, armed; mandibles hooked or styliform.	Terrestrial 1. *Trombididæ*	Erythræinæ Trombidinæ Cheyletinæ Scirinæ Tetranycinæ Cæculinæ Limnocharinæ
				Fresh w. 2. *Hydrachnidæ*	
				Marine 3. *Halacaridæ*	
			Palpi free, unarmed; mandibles in form of cheliceræ.	4. *Bdellidæ*	Bdellinæ Eupodinæ
		B. Tracheæ opening at posterior part of body, at the base of the feet. **Metastigmata.** Body having a ventral sternum or plastron.	Palpi free, unarmed, tactile; mandibles hooked.	5. *Gamasidæ*	Nicoletiellinæ Uropodinæ Gamasinæ Dermanyssinæ
			Palpi tactile, mandibles hooked; mandibles in form of chelicerae.	6. *Ixodidæ*	Argasinæ Ixodinæ
			Palpi free, tactile, fusiform.	7. *Oribatidæ*	Oribatinæ Nothrinæ Hoplophorinæ
		C. No tracheæ. **Astigmata.** Body having epimera below. Palpi adhering at their base, slender, tactile; mandibles in form of chelicerae.		8. *Saracoptidæ*	Tyroglyphinæ Canestriniinæ Listrophorinæ Analgesinæ Sarcoptinæ Chirodiscinæ
	Order II. **Vermiformia.** Abdomen distinct from cephalothorax, ringed. No tracheæ.	A. **Octopoda.** 4 pairs feet, palpi armed, mandibles styliform, immovable.		9. *Demodicidæ*	
		B. **Tetrapoda.** 2 pairs of feet, palpi unarmed, mandibles styliform, movable.		10. *Phytoptidæ*	

yellow, the beetles were found almost exclusively upon the latter varieties, apparently preferring white to yellow, and undoubtedly choosing one of these in preference to the red. On bright days a dozen would sometimes be found in a single white tulip, and two or three hundred beetles were collected from the patch.

It is probable that at the time these visits were made the beetles had not yet laid their eggs. Some were observed mating. Consequently gathering and destroying them on these early spring blossoms is a simple means of checking their increase. I saw a few on white and yellow crocuses, but none on other flowers, wild or cultivated, except the tulips.—CLARENCE M. WEED.

Association of Economic Entomologists.—Mr. F. M. Webster, Secretary, has issued the following announcement concerning the next meeting of this body: In accordance with an action of the Association, taken at the Washington meeting, the fourth annual meeting will be held at Rochester, New York, two days prior to the meeting of the American Association for the Advancement of Science.

All members intending to present papers are requested to forward titles to the Secretary before August 1st, in order that the program may be prepared in proper season.

The proceedings of our meetings are attracting the attention of working entomologists of other countries, and it is to be hoped that members will spare no efforts to make the coming meeting even better than those which have preceded it. Owing to the continued ill-health of President Lintner, and in order to relieve him of as much labor as possible, all correspondence, unless of a nature necessitating his attention, may be addressed to the Secretary, at Columbus, Ohio.

Dr. Lintner's seventh report on the injurious and other insects of the State of New York has lately been published. It covers the year 1890, and forms a very creditable volume of more than 200 pages. The injurious insects treated of include the poplar saw-fly (*Aulacomerus lutescens*), the black and red woolly bear (*Pyrrharctia isabella*), the prolific Chlorops (*C. prolifica*), the chrysanthemum fly (*Phytomyza chrysanthemi*), the bean weevil (*Bruchus obsoletus*), the lentil weevil (*Bruchus lentis*), and the periodical Cicada (*C. septendecim*). Then follows a large number of interesting notes on various insects, an account of two injurious arthropods, the clover mite (*Bryobia pratensis*) and a household centipede (*Cermatia forceps*), two entomological papers of general interest, and a list of publications of the

entomologist. The whole volume shows the same careful preparation as its predecessors, and is well illustrated, a number of the figures being new.

Notes on the Clover Mite.—This little creature (*Bryobia pratensis*) has been extremely abundant during the past spring at Hanover, N. H. It appeared in swarms early in April, congregating on window-sills of houses and other buildings, and continued abundant until early in June. In Dr. Riley's recent Insect Life article upon the species it is surmised that at the north the mite passes the winter in the egg state, but this evidently is not the case in the latitude of Hanover.—C. M. W.

Entomological Notes.—A bulletin (No. 19) of unusual interest comes from the Colorado Experiment Station. It contains Prof. Gillette's "Observations Upon Injurious Insects, season of 1891." It includes discussions of the fruit-tree leaf-roller (*Cacoecea argyrospila*), box-elder leaf-roller (*C. semiferana*), grape-vine leaf-hopper (*Typhlocyba vitifex*), gooseberry fruit-fly (*Trypeta canadensis*), imported currant borer (*Sesia tipuliformis*), and several others. There are twelve good illustrations, all but one being original.

Number 4 of the current volume of the Ohio Station Bulletin contains an extended discussion of the "insects which burrow in the stem of wheat." by Mr. F. M. Webster. Eight species are enumerated.

At the next meeting of the Association of Agricultural Colleges and Experiment Stations, Chairman Lawrence Bruner, of the Committee on Entomology, proposes to describe the working facilities, library, collections, equipment, etc., of the various entomologists represented in the Association.

Prof. S. A. Forbes, in charge of the entomological exhibit at the World's Fair, is endeavoring to get together a biological collection of all the insects whose life histories have been worked out in whole or in part by the experiment stations.

In Bulletin No. 19 of Hatch Experiment Station of Massachusetts Prof. C. H. Fernald has published an excellent account of the present status of the gypsy moth (*Ocnerea dispar*), illustrated by an admirable colored plate showing the various stages of the moth, a map of the

region infested in 1891, and four reproductions of photographs of the effects of the caterpillar's work. The same bulletin contains an account of certain cranberry insects and of various entomological experiments.

In the April, 1892, issue of *Entomologist's Monthly Magazine* Dr. E. Bergroth describes as *Dulichius wrongtoni* n. sp. an ant-mimicking hemipteron found in India. It mimics the Indian ant (*Polyrrhachis spiniger* Mayr), to which it is said to have a most striking resemblance.

In the same issue of the same magazine Mr. Chas. Fenn describes "the pole system" of collecting Tortrices. It consists essentially of the use of a net of large diameter on a very long pole made of jointed bamboo rods, by means of which small moths flying about the tops of trees can be captured during the day.

SCIENTIFIC NEWS.

—THE attempts made in past years by the paleontologist of the U. S. Geological Survey to prevent other paleontologists from making collections in the west are now familiar to most of our readers. A recent enterprise in this direction quite equals any of the former ones in effrontery. We learn on the best authority that Prof. O. C. Marsh has been pursuing his old tactics in the case of Prof. Osborn, of the Museum of Natural History of New York. He commenced his attack, as heretofore, by charging that dishonest methods were employed by the Professor of the Museum in obtaining specimens which really belonged to him, Prof. Marsh ; and so to damage the character of Prof. Osborn with the management of the museum. These charges having been refuted, he proceeded to inform the trustees that he could not, as Government paleontologist, permit collections to be made on Government land. This not producing the desired effect, he preferred a claim based on scientific comity that he had a fair right to exclusive work in the Laramie field. The trustees of the museum failed to see the justice of this proposition, even if the claim of priority were true, which it is not. Prof. Marsh then descended to other and quite childish forms of appeal not necessary to mention here.

It remains to be seen what the U. S. Geological Survey will do with this psychological phenomenon. The demonstration of Prof. Marsh's unfitness for the position is now ample, and more is to come. But apart from all personal characteristics, such as are above described, we think it would be well if the Government material could be properly worked up and reported on. His only volume published by the present survey, that on the Dinocerata, is a good example of perfunctory work. Of the, say twenty-seven, species included in it, the remains of but one or two are described from the material actually enumerated by Prof. Marsh, the remainder of the work being left to some successor who may feel disposed to attempt a task for which all the credit has been already assumed by another. The neglect of other authors displayed in all his writings become more conspicuous recently, is also reason enough for the withdrawal from him of the aid and countenance of the U. S. Geological Survey.

—M. FRANCOIS BOCOURT, the distinguished author of the Herpetology of the Mision Scientifique de Mexique, has been retired from his

position in the Museum of Natural History of Paris. He is replaced by a retired officer of artillery, whose fitness for the place remains to be demonstrated. M. Bocourt, besides his special zoological knowledge, is an admirable artist, and his plates of reptiles are the most beautiful and accurate ever published. His retirement is greatly to be regretted, and the suspension of his work before completion will be a discredit to France. It is to be hoped that this action will be reconsidered, or if not, that provision will be made for the completion of his great work.

Biology at the Leland Stanford Junior University.— Biology had no prejudices to conquer at Leland Stanford Junior University. The President has faith in the Biological Sciences and sympathy with the laboratory methods in their study, while of the students who at the beginning applied for work in the University a fair proportion looked to these sciences for a part of their training. So, from the start, departments in biological lines were established, laboratories arranged for, and students have come forward to fill them.

Departments were established by the appointment of Dr. Douglas H. Campbell to the chair of botany, of Dr. Charles H. Gilbert to the chair of zoology, Prof. John H. Comstock to that of entomology, and of Dr. Oliver P. Jenkins to that of physiology and histology. To each of these gentlemen was left the direction and equipment of the department to which he was called. The appointments came at a time when it was impossible to predict the attendance in general for the present year, or what would be the number of students to be accommodated in each department. The pleasure of ordering a lot of new apparatus was spiced by the attempt to plan it for an unknown and an unknowable class. To attempt, for example, to order such a number of microscopes as would neither, as unused, stare one in the face for a year and reproach him for his extravagance, nor leave him to increase his work with relays of students on a short number, was a problem which demanded careful consideration. Most concluded to take their chances on the first horn of the dilemma to find themselves later hung up on the second. Thus it has turned out that some of the first orders have had to be supplemented or even duplicated.

The two buildings assigned to these departments were not originally intended for laboratories and are to be so employed only until the permanent biological laboratories shall be built, which exist in the plans for the near future. At present the departments of botany and physiology share one of the two buildings on the west side of the quadrangle. It is a stone building, well lighted, very pleasant, and with the

lecture rooms and offices, store room and large laboratory conveniently connected.

The planning of the furniture of the laboratories was left to the professors of the various departments. This necessitated the doing of a great deal of such work in a short space of time, and resulted in some delays. But when it is considered how much was to be done, both in furnishing and in getting together apparatus and books from such great distances, it is remarkable how few and short these delays were.

Notwithstanding these difficulties, work began in the departments with the very opening day. Not all orders were in, but enough were in to start things going, and where tables had not arrived the packing boxes of newly arrived apparatus were improvised for their support, and abandoned carpenter benches performed new duties, becoming daubed with paraffine, doused with alcohol and littered with interesting Pacific coast forms of animals and plants. Of these latter there is no lack. They preceded the apparatus and bid fair to keep in excess of all appliances.

The botanical laboratory is furnished with forty-one compound microscopes, including one new Zeiss stand with a series of apochromatics, also microtoms, imbedding apparatus, aquaria and the necessary glassware, sterilizing apparatus, and all the most used reagents. During the past year thirty-five students have occupied tables in the botanical laboratory.

In the department of physiology and histology thirty-two students, three of whom were graduate students, have been in attendance. For work in these subjects the laboratory is supplied with thirty-six compound microscopes, a number of dissecting microscopes, two Minot's microtomes, imbedding apparatus and material, a plentiful supply of fixing, hardening and staining reagents, mounting materials, etc. For work in experimental physiology there are provided kymographs of different forms, two registering cylinders of Ludwig's form and one for continuous paper, a pendulum myograph, apparatus for muscle and nerve phenomena, galvanometers and other apparatus for electrical experiments with nerve and muscle, oncometers, plethysmographs, various forms of electrical signals, manometers, time markers, tuning forks for time, apparatus for respiration, for the study of optical and auditory phenomena, tambours, cardigraphs, arteriographs, tonometers, spectroscope, polariscope, spectrophotometer, apparatus for urinalysis, for digestion experiments, dissecting instruments, batteries, etc.

The department of zoology has been quartered in the building at the southwest corner of the quadrangle, containing a lecture room, two laboratories, a small museum room and an office. For the work there are provided twelve compound microscopes, dissecting microscopes, dissecting instruments, collecting apparatus, museum specimens, a series of skeletons, and the other usual appliances of such laboratories. Abundant material for the work has been obtained from the coast.

Advanced work in ichthyology has a considerable stimulus in the presence of a very valuable collection of fishes consisting of over 2,000 species. These are made up in part of carefully selected species from the great collection which had accumulated at the Indiana University by the work of Drs. Jordan and Gilbert and their former students, and in great part by the deep sea dredging of the Albatross in the Pacific, made mainly under the direction of Dr. Gilbert; and in addition a considerable collection of fishes from the Sandwich Islands made by Dr. Jenkins. Thirty students, two graduate students have been accommodated in the department.

The laboratory for the department of entomology is in one of the buildings in the west end of the quadrangle. Prof. Comstock was present during January, February and March of the present year; the work is carried on during his absence by an assistant. The laboratory possesses already a considerable collection of California insects, and there has recently been purchased a very valuable collection of Lepidoptera containing about 2,000 species. Twenty-three students, one graduate student, have taken the work during the year.

The number of students who have applied for work in all these laboratories has been so great that new quarters for their accommodation for the coming year have been arranged for.

The biological work of the University is to continue through the summer at the newly established Hopkins Seaside Laboratory, located at Pacific Grove, on Monterey Bay. The building, now completed, is a substantial wooden structure 60 by 20 feet, especially planned for the work, and exceptionally well lighted. It has on the lower floor two general laboratories, a library and reading room, and a store room; on the upper floor are one general laboratory and six private rooms. In all about fifty students can be comfortably accommodated. The building is a gift of the Pacific Improvement Company and the people of Pacific Grove. The general furnishing, including the pumping plant, aquaria, tables, etc., are furnished through the liberality of Mr. Timothy Hopkins. The microscopes, microtomes, collecting and

other apparatus, as well as the books used are from the University. The location of the laboratory is a most charming one, on the edge of a low cliff overlooking a beach which presents greatly varied collecting grounds. The forms of both animal and plant life are extremely rich in both number and species.

Drs. Gilbert, Jenkins and Campbell are the directors. Three classes of students will be provided for: Students in the biological sciences in the Leland Stanford Junior University; teachers and others wishing to take an elementary course, and investigators. To the last class the use of the laboratory is granted free. The first two classes pay a moderate fee to cover running expenses. Great effort is being made by the directors to get together the means for comfortable and efficient work, and everything bids fair for a profitable summer at the new workshop of science.—O. P. J.

The paleontological exploring expedition sent out by the Museum of Natural History of New York is reported to have been successful in its researches in the Puerco district of New Mexico. Dr. J. L. Wortman, who is in charge, states that the weather was very unpleasant, owing to wind, dust, heat and drought, but that many valuable specimens were obtained. He goes later to the Laramie region to collect Agathaumidæ and other characteristic forms of that horizon.

The session of the Summer School of Science for the Atlantic Provinces of Canada, which opens in St. John on Monday evening, August 1st, will, from present appearances, be largely attended. Arrangements are being made to secure the comfort of those who attend. Intending visitors should make early application for boarding houses, stating what price they wish to pay. Arrangements have been made for reduced fares by rail and steamer. A large gathering from Nova Scotia is promised, and the New Brunswick teachers are expected to be present in considerable force.—*Educational Review.*

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PLATE XXI.

Bifurcated Annelids.

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BIFURCATED ANNELIDS.

BY E. A. ANDREWS.

Abnormal structures among non-vertebrates have come under the observation of everyone who has carefully examined a large number of individuals in any group. Just as there are many cases of duplication of parts occurring among the higher vertebrates, so among the non-vertebrates we have recorded cases of the same nature. As might be expected, this tendency to produce supernumerary parts is most easily noticed in such groups as the crustacea, insects, echinoderms, where the nature of the skeleton aids in the recognition of abnormalities. Even among the soft-bodied animals, however, many cases of abnormal duplication of parts have been recorded.

For the group Annelida, such records are scattered and not generally known or accessible. To bring these together with the hope of eventually obtaining material for a more complete view and discussion is the object of the present article.

We will limit the review to cases in which the main axis of the worm is duplicated, to some extent, at one end of the body, so that the animal has there two left and two right sides, has either two heads or two tails.[1]

In the last quarter of the eighteenth century Charles Bonnet (1), while experimenting upon the power of regeneration

[1]The author would be glad to receive references to literature upon this subject and if possible the privilege of examining specimens showing such bifurcations.

in certain freshwater annelids (naiads) found that there was sometimes a sort of tubercle formed upon the body, leading, he imagined, to the formation of new individuals by stolon-like outgrowths! In one case an individual was cut into three pieces; the posterior piece formed a new head for itself and at the same time gave rise to one of these tubercles, which Bonnet regarded as a second head. This specimen is shown in fig. 7, and its bifid anterior end in fig. 8.

Such tubercles occurred at the posterior end also, and in one case, in another species of fresh-water annelid, two definite tails were observed. These two cases seem to have been the only ones noticed among very many individuals carefully observed during these experiments upon regeneration of parts after artificial section.

Towards the middle of the present century Edward Grube (2) cites the case observed by Schäffer, who had made unsuccessful attempts to obtain reproduction of lost parts in the fresh water annelid *Sænuris variegatus* Hoffm.

In this one case an individual with two definite tails was found a few weeks after Schäffer had cut the bodies of the annelids into pieces in the hope of having them form new ends.

More recently C. Bulow (3) made a long series of experiments upon the regeneration of lost parts in *Lumbriculus variegatus* Gr., and discovered among his specimens some cases in which there were two well-formed tails. In one individual, 5.5 cm. long, each tail was 1.75 cm. long.

About the same time Zeppelin (9) found three cases of bifurcated posterior end in the simple, perhaps primitive, annelid Ctenodrilus. Two of these are shown in figs. 1 and 3. These were obtained among several hundred specimens carefully examined in studying the peculiar reproduction by budding found in the Ctenodrilidæ. This process consists largely in the reproduction of lost parts after the animal has spontaneously divided itself into small pieces consisting of only a few somites.

The above cases of bifurcation of the main axis in aquatic oligochaetous annelids have been discovered during special

researches upon these small and not commonly observed animals. In their terrestrial allies, however, among the well known earthworms, cases of such striking monstrosities have fallen under the observation of many casual observers.

In Europe Charles Robertson (**4**) described and figured such a case in *Lumbricus terrestris.* As shown in figs. 4 and 5 the body is divided into two equal posterior parts, at the 85th somite. Each begins with a perfect somite and thus leaves a triangular membranous area on the dorsal and ventral sides of the trunk. The length to the fork was two inches; that of each caudal portion ⅛ inch. Each portion had about 20 somites and contained a portion of the forked intestine, chief blood vessels and nerve trunk; had well developed setæ and a separate anus. The animal appeared to be an adult, having fully and normally developed sexual organs.

This description was drawn from an alcoholic specimen in the Oxford University Museum. F. Jeffrey Bell (**5**), however, had a live specimen of the same species under observation for two months. This was a small immature individual represented in figs. 10, 13 and 14, in which, however, the clitellum began to appear shortly before death. Before dying, the left tail, which was shorter, became less and less active and relatively shorter till finally both tails were thrown off or disappeared and death ensued.

He also observed a dead specimen of *L. fœtidus* in which there was a forked posterior end.

Horst (**6**), in experimenting upon regeneration of lost parts in earthworms, found one 100 mm. long with two tails, each 25 mm. long and quite normally formed. This again was a living specimen when observed.

On this side of the Atlantic, Asa Fitch (**7**) seems to have been the first to record the occurrences of such monstrosities. Among some interesting observations upon the habits of earthworms, regarded as *L. terrestris,* he records finding in his garden in New York State, a live specimen about three inches long with the posterior end divided for nearly one fourth of this length. These appendages are equal, but each only about two-thirds the normal thickness of the body anterior to them.

Each appendage possessed a functional anus. The left appendage appears as a continuation of the body, three somites serving to form a gradual transition from the thicker trunk to the thinner appendage. The right appendage springs out from the gaping suture between the trunk and the first of the three transitional left somites; where this origin of the right branch occurs there is a slight constriction not represented at all upon the left branch. The method of bifurcation seems thus similar to that figured by Robertson, fig. 4.

Very recently C. Dwight Marsh (**8**) records a two-tailed earthworm found in Wisconsin. While alive both tails appear of equal importance, but in alcohol one division is markedly constricted where it joins the body and appears as a mere lateral branch. Each appendage has a branch of the intestine and of the nerve trunk, as well as a functional anus. In alcohol the specimen is only 34 mm. long, the tails each 12 mm.

Among the marine polychætous annelids instances of duplication of the main axis have been recorded for several most widely separated families.

Thus amongst the sedentary Serpulidæ, Edouard Claparéde (**10**) found a *Salmacina incrustans* in which the posterior end was bifurcated as in fig. 2, each part having an anus.

Among the nearly related family Sabellidæ, Brunette (**11**) found, in an unknown species of Branchiomma, one case in which there were two posterior ends, the smaller one making an angle of 30° with the larger. The smaller end is a newly formed one having the fæcal groove less marked than upon the older end, and the ventral shields scarcely visible. The whole annelid is small, 6 cm. x 6 mm., while the new posterior end is 1 cm. long and attached about 15 mm. from the tip of the older posterior end. Here then we have to do with a case of unequal bifurcation, one part appearing as a new formation grown out from the side of the normal animal near its posterior end.

Among the errant Polychætæ, in the family Syllidæ, Paul Langerhans (**12**) found a remarkable case of bifurcation, not of the posterior, but of the anterior end. This, the only well

authenticated case of double-headedness amongst annelids, was seen in a specimen of *Typhlosyllis variegatus* Gr. from Madeira. As shown in fig. 6, the left head has two somites more than the right. As the author notes, and as the figure indicates, the specimen appears to have lost its original head and to have grown there two new ones, having been broken off just anterior to the pharyngeal tube. This, with its dentition, is of the normal size and could not be used in connection with either of the two small heads.

In the same family a case of bifurcation of the posterior end in *Procerea tardigrada* Wb. was observed in North Carolina by E. A. Andrews (**13**). Among several hundred specimens seen during two successive seasons two cases of such bifurcations seem to have occurred, one being found by Prof. Nachtreib. In the one represented in fig. 9 the animal moved actively, each long tail crawling like the normal termination of the body. Each has also the peculiar red transverse bands of this species. Though nearly equal in length and diameter the two tails have unequally perfected posterior tips, as seen in figs. 11 and 12, the right lacking the normal anal cirri. In fact this right tail was interpreted as a sort of lateral outgrowth from the more perfect left tail. This was one of the common non-sexual individuals in which the sexual head was forming upon the fourteenth somite as usual, preparatory to a separation of all the following region as a sexual individual, in this case, a female, which would then have two tails to burden it in its more active mature life.

The only other case that I find record of is that of a *Nereis pelagica*, observed by F. J. Bell (**14**), a specimen sent from Guernsey and exhibited at a meeting of the Zoological Society of London. Beyond the fact that the specimen was bifid at the posterior end no information is given concerning it.

Thus among the many hundred annelids carefully studied and among the thousands more or less casually observed there were found, as far as this imperfect record extends, only about twenty cases of bifid ends. Of these only two were cases of duplication of the head end. Only eight cases have been fig-

ured and these, as seen in the accompanying plate, leave much to be desired regarding the details of the bifurcations.

The period in which these monstrosities arose is not well known; whether they were present in the embryo or were formed in the maturer period of the individual's existence. Yet there is little support for the former supposition, while for the latter we have in two cases good evidence and in many others considerable presumption towards this conclusion. Thus the case shown in fig. 6 can hardly have arisen otherwise than as a consequence of the loss of a normal large head in which the normal pharynx could function. Again, the somewhat doubtful double-headedness of the annelid figured by Bonnet, figs. 7 and and 8, is explicitly stated by him to have arisen after the normal anterior portion had been cut off. Moreover a considerable number of the observed cases have been found while experimenting upon the power to reproduce lost parts.

Granting for the present that these monstrosities have arisen in late life after removal of parts of the main axis or after injuries, we may next enquire how far the two new ends are of equal or unequal value, whether, as figs. 2 and 4 would indicate, the two new parts are equal in origin or whether one, as in fig. 10, etc., is to be regarded as a subordinate part or lateral outgrowth from the main trunk. In both cases of double-headedness, figs. 6, 7, 8 the left is the more complete of the two heads; amongst the cases of bifid posterior ends three have the left more developed, one the right and two others an undetermined side exceeding the other. Only two, figs. 2 and 4, are known to have undoubtedly equal ends.

As far as the evidence goes (and it is too scanty to warrant binding conclusions), there is some indication that one of the heads or tails is a supernumerary part growing out, often on the right, as a somewhat imperfect duplication of the normal end or continuation of the main axis.

Whether the two branches are at first equal, as in fig. 2, and subsequently become unequal or, as seems probable in many cases, one is at first only a side bud on the main axis, cannot be determined as yet.

The interpretation of one of the two parts as a lateral outgrowth allies this process to that described by McIntosh (**15**) in the remarkable *Syllis ramosa*. This annelid lives inside of sponges and presents the anomaly that its buds, instead of being confined to the direction of the main axis, may be also lateral, so that branches and sub-branches arise and produce a complex system with many ultimate tips that may become liberated as sexual animals. How far this lateral budding may be in each case brought about in connection with injuries is not known, but there seems to be an intimate connection between injury and budding, and McIntosh remarks, "the body of the annelid appears to have a great tendency to budding—laterally, terminally and wherever a broken surface occurs."

If, in this remarkable Syllis, budding has been acquired as a result of power to regenerate lost parts, as has been urged by Lang and v. Kennel for other cases of budding among annelids, it is a recent and secondary process. Not so the regenerative power itself which is to be met with in a peculiar form in the double embryos of certain earthworms which arise, as claimed by Kleinberg and corroborated by Wilson, from a single egg. Still further back there seems to be in the ovum a double potentiality. Thus Hans Dreisch[1] claims to have produced complete larvæ from half eggs, that is that the egg, in the Echinus studied, might have formed two larvæ or two adults.

Whether then in the reproduction of lost parts we have the formation at *successive* periods of duplications of the main axis to replace those lost, or in the cases of bifurcation (interpreted as somewhat like lateral budding), we have the *simultaneous* formation of duplications of the main axis, in either case the important fact is that the egg-individual may exhibit a power of reproducing its main axial parts without a sexual process. The bifurcated monstrosities thus exhibit what may be a universally present but latent ability of parts of a highly organized animal to form a complete individual like that to which they belong.

Baltimore, Md., May 5, 1892.

[1]See the AMERICAN NATURALIST, Feb., 1892, p. 178.

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14. Bell.—Proc. Zool. Soc. London, p. 3, 1887.

15. McIntosh.—Challenger Reports, xii, 1885.

Explanation of Plate.

Fig. 1. *Ctenodrilus monostylos* x 12½. Zeppelin (**9**), pl. 36, fig. 18.

Fig. 2. *Salmacina incrustans.* Claparéde (**10**), pl. 30, fig. 5F.

Fig. 3. *Ctenodrilus monostylos* x 22½. Zeppelin (**9**), pl. 36, fig. 19; drawn from a living specimen; not that shown in fig. 1, above.

Fig. 4. Posterior end of *Lumbricus terrestris.* Robertson (**4**).

Fig. 5. Same as fig. 4, but cut open to show intestine and dorsal blood vessel.

Fig. 6. *Typhlosyllis variegatus,* with two new heads. Langerhans (**12**).

Fig. 7. Posterior part of a naiad cut into three pieces and forming two heads (?) Bonnet (**1**), pl. 1².

Fig. 8. Enlarged view of anterior end of fig. 7. Bonnet (**1**), pl. 1[2], fig. 16.

Fig. 9. *Procærea tardigrada,* non-sexual form with a male bud having two tails; drawn from nature.

Fig. 10. *Lumbricus terrestris,* drawn from living specimen. Bell (**5**).

Fig. 11. Posterior end, enlarged, of the left tail of fig. 9.

Fig. 12. Posterior end, enlarged, of the right tail of fig. 9.

Fig. 13. Same as fig. 10 but drawn while in another position.

Fig. 14. Same as figs. 10 and 13.

BRAIN CENTRES.

By S. V. Clevenger, M. D.

Gradual and better understanding of the nature of the brain and its workings is being acquired and disseminated by investigators and thinkers (who are not always one and the same). Twenty years ago the most incorrect ideas concerning the brain existed, consisting of a mingling of superstition with the incorrect phrenological deductions of Gall, Spurzheim, and their followers. Fritsch and Hitzig by experimentation upon dogs, Ferrier upon anthropoid apes, and the imitators and elaborators of their methods, foremost among whom stands Munk, have prepared the way for thinking pathologists and histologists such as Exner, Meynert, Spitzka, and von Gudden, for verification of previous findings.

All too often the patient drudge of a microscopist, fully equipped with special technical knowledge, while able to accurately describe what he saw, was unable to interpret its significance, and quite as often those who are capable of making profound generalizations lack the data, the means or the time, necessary for research. A research with the brain is quite as important as that with the eyes or other sense organs. In fact it was not till the world had investigators with brains as well as eyes, such as Linné, Lamarck, Cuvier, and Darwin, that the investigating eyes knew what to look for, or recognized it when they had found it.

The methods by which the motor centres in the brain were localized are simple enough. After a piece of the skull of an animal was removed, electrical stimulation of certain definite parts of the bared brain invariably produced certain muscular movements. Applied at one point the fingers would move, at another a certain arm movement would occur, and thus leg, tail, face, and tongue movements were induced, and often the muscular coördinations thus evoked were quite complicated, as in swimming, grasping, running, and emotional expression. Cutting away these same small portions of brain tissue pro-

duced paralysis or loss of ability to voluntarily perform these same motions. Tumors or the rupture of blood vessels in these brain regions also cause these paralytic conditions and confirm the results of experimentation.

Destruction of other portions of the brain enabled the localizing of centres for the special senses, and thus we have ascertained that the optic centre is in the hindmost tip of the cerebrum, the auditory is two or three inches farther forward. The centres thus far accurately located are those for sight, and hearing and those controlling the motions of all parts of the extremities, the head, and the vocal apparatus.

Notwithstanding the large size of the olfactory tract at its junction with the brain the smelling centre has not yet been undisputedly made out. There are many portions of the brain the functions of which have not been discovered because present methods of observation are insufficient. There are certain phenomena that follow upon injury of other portions, such as loss of sensation, elevation of bodily temperature, incoördination, vertigo, but, as any one of these kinds of disturbances may be produced by injury to several different areas, strictly speaking we cannot regard such pathological processes as indicating physiological centralization.

The clustering of certain motor nerve beginnings for coördinating processes into closely aggregated nuclei, warrant, to a qualified extent, such terms as crying, laughing, sneezing, and vomiting centres, and as laughing and crying are regarded as emotional exhibitions, the conclusion has been jumped at that the medulla, where these nuclei are found, is the emotional centre. Then there is a sort of hazy idea derived from phrenological assumptions, that there is a centre for memory, another for sexuality, others for combativeness, mathematics, and so on.

Examining by reasoning processes certain faculties that are dependent upon brain integrity, we may arrive at conclusions that are valuable from both positive and negative points of view. The negations afforded by science make us intellectually superior to superstition, though they may not, for the nonce, give us "something else instead" of our fetiches.

SEEING, HEARING AND TOUCH have been considered incidentally in this article, and my contribution to THE AMERICAN NATURALIST, July, 1888, entitled "Cerebrology and Phrenology" contains a discussion of mental faculties in general and in detail from the old and new points of view.

TASTE and SMELL. These two special senses are associated in food discrimination to such an extent as to be often confused one with the other. As might be imagined, the simpler reflex organization of the lower invertebrates relating mouth motions to these senses grow more complex the higher the animal, until considerable brain tissue is concerned. For example, the infant wants to eat everything it sees and its arm and mouth reflexes respond to sight, smell, and taste in endeavors at swallowing everything visible, including its fist and the moon. Olfaction is the main food discriminating sense below the primates, the olfactory bulbs at the base of many lower mammalian brains being very large.

In 1884 I published the original view that the hippocampus major related the olfactory sense to the eating motions. The hippocampus major passes from the olfactory nerve roots backward and finally curls upward and forward to the post frontal region, where are centres for the lips, tongue, and deglutitory parts generally. The Huxley-Owen controversy over the hippocampus minor ended in the former demonstrating its presence in anthropoid ape brains. The animus of the denial was to show a radical difference between "lower animals" and man in the absence of a cerebral part.

I am not aware that anyone has preceded me in announcing the probable functions of the hippocampi. The major is large, and, in keeping with its size, must have subserved some very important life relation, and what is more likely, considering its beginning and termination, its relationship to other brain parts, and its zoological distribution, than that it brought the smelling, tasting, and eating apparatus into coöperation.

In man and the higher apes the olfactory has given way to optic intelligence generally, and in judging of food wholesomeness the eyesight is relied upon mainly, which would

account for the obsolescing features of the major in man, and the absence of the minor below the apes.

The minor projects into the occipital lobe in the region allotted to optic intelligence. The relative sizes of the hippocampi may be explained by remembering that millions of years may have been occupied by Mammalia with olfaction as the main means of food discrimination in their evolution, and that relatively much less time has elapsed since the apes and man first appeared. The hippocampus minor develops as the optic sense becomes the superior means of food judgment; and as the olfactory importance diminishes, the hippocampus major degenerates.

That the taste and olfactory centres are not definitely determined depends, in my opinion, upon the intimate blending of these senses with motor eating centres, paralysis of which becomes so noticeable as to overshadow the sense loss, which latter may be overlooked or regarded as not necessarily an associated derangement. Lesion of the temporal lobes destroying the smelling sense may indicate no more than that olfactory fibres pass through those parts. Taste has reflex connections of a lower than cerebral nature that regulate many involuntary acts concerned in eating, but by association pretty extensive brain distributions are also concerned, more particularly optic, and the glosso-labial motor areas near the sulcus of Rolando. So we may say taste and smell are more generalized than centralized through the brain, and that in man the smelling sense is losing importance.

Consciousness is at its fullest when we possess every faculty intact. Deprivation of the special senses necessarily interferes with consciousness, though, as in the Laura Bridgman case, the possession of a single sense, which has been trained to subserve purposes of contact and communication with the outer world, may suffice. Circulatory disturbances in the brain affect consciousness in various ways, sometimes abolishing it for a time. Proper regard for these and other such matters as sleep, epilepsy, compression of the brain, and a multitude of considerations requiring too much space to even epitomize here, lead me to deny that consciousness has any

localized area in the brain, but resides in the total functionating parts of that organ. For instance, in a healthy brain the entire nervous and vascular tissue, in its solidarity, is the seat of consciousness. Derangement of a part may interfere with action of the brain as a whole, and until adjustment to altered conditions has occurred, there may be deranged or lost consciousness. Now if an attempt at compensation be made by reparative processes, a new consciousness may be instituted, but correspondingly degraded in proportion to whatever permanent damage the brain may have sustained. So while there is no special cerebral seat of consciousness, the entire brain is concerned therein, and the quantity and quality of consciousness will depend upon the equivalent integrity, construction, and size of the brain as a whole.

MEMORY has been well demonstrated as consisting of memories. There is a memory of what has been learned by eyesight, located in the back part of the brain; forward of this, a memory of all that has been acquired through hearing. Touch memories are scattered over the brain surface co-extensively with motor centres for the peripheries from which the impression proceeds. This is based on Munk's claim that tactile and motor centres coincide, though this is still under discussion. Taste and smell may be safely inferred as having probable centres, and the memory of things tasted and smelt reside therein. In addition to these there are motor memories (the "*Bewegungsbilder*" of Kussmaul), which lie between, and in, the muscles, the nerves that innervate them, and the cells that lie in the outer part of the brain, and which are connected with those nerves. Then memory has no special seat, but has many brain localities devoted to different kinds of memories.

VOLITION. That the so-called will power controls such a great number of parts would of itself argue that volition exercised the centres of innervation of those parts.

As volition is merely the strongest impulse, and is aroused or checked by single or multiple reflexes, the centres for which are scattered throughout the spinal cord and brain, it is plain that there can be no special seat for the will power. The voluntary activities are the measure of volition and all the

body activities, voluntary and involuntary, instigate it. Molecular changes in and about us influence and control it; digestive processes, fatigue, rest, good or bad air, sicknesses, as well as mental impressions, guide it, raise and depress it. Its starting point is everywhere in the body, its reflex centres are everywhere in the brain.

Sexuality (to borrow a phrenological term) is sometimes apparently augmented by brain injury. This I interpret as indicating that full brain integrity diverts or holds in check the manifestations of an appetite that belongs to every cell of the body. There are automatic spinal cord centres connecting the genitals through the nervi erigenates, but so far as intelligence is concerned in sexuality, a great number of mental associations exist differing between individuals; these are mainly optic in man, and olfactory in most other Mammalia. There need no more be a special localization in the brain for sexuality than for hunger, and these two instincts are at the very foundation of life, and exist in every part of the body, controlling, directly or indirectly, every act and thought. So hunger and sexual desire are co-extensive with the distribution of volition throughout the body and brain.

The Emotions have vaguely been regarded as having several centres or a single centre. Often in physiological writings we encounter the term "emotional centre" and reasons more or less incorrect have been advanced locating this "emotional centre" at the base of the brain.

Emotionalism in a broad sense is nothing more nor less than degrees of excitement. So from this standpoint it is a condition, an exaltation or depression of the nerve centres, and hence it would be absurd to look for its centre. Joy, grief, anger, fear, jealousy, are all conditions which may engage every cell in the body at times. The fact that there may be crying and laughing centres in the medulla do not constitute that portion an emotional centre any more than we are justified in calling the leg centres in the brain cortex, kicking centres. The laugh and cry may be purely automatic and without reference to the emotions at all. Besides, some emotional exhibitions, such as tremblings and pallor, indicate that during emotional excite-

ment nerve force is pretty well diffused throughout the body, and that no particular set of nerves is engaged. It would seem that in such instances there is excellent evidence of the absence of an emotional centre and the shaken up general nervous system can find no special outlet for the feeling.

When a rupture of a blood vessel in the motor centres of the brain causes paralysis, and in brain degenerative states, such as are induced by alcoholism and senility, there is an increase of emotionalism; the patient may cry and laugh easily, but in such instances the higher control is lost, impressions are diverted from former channels in the brain to the more automatic ones lower down, but the emotionalism is the product of brain injury and is a debased condition, and hence has no centre in the brain. The fact that the brain base at its junction with the spinal cord has laughing and crying reflex centres may warrant this area being named an emotional centre in a very limited sense, but strictly speaking, there can be no such thing as a centre for the emotions, for laughing and crying are but two among a great number of emotional exhibitions and they may occur independently of consciousness.

INSTINCT AND REASON. A study of the construction of the nervous system should convince anyone that the more definite the tracts that pass between nerve centres and muscles engaged in habitual performances, the more instinctively are motions enabled. Muscles are developed by exercise, and certain kinds of work give special peculiarities to those muscles, and it is reasonable to suppose that nerve bundles passing to such muscles, and the nerve centres in the cord and brain are, through participating in the work, also developed, arranged, and adjusted, to enable harmonious adaptation of means to ends. When one becomes an adept at piano playing, a trade, etc., many complicated acts may be performed "instinctively," automatically, and even unconsciously, as during somnambulism, some epileptic feats, or in the routine work of daily normal life. We would infer from this that the acts instinctively performed by animals, even when just born, are reflexes that depend upon a definite arrangement of nerve strands transmitted in many cases through ages.

Reason, on the other hand, is often engaged in holding such reflexes in check. Deliberation, hesitation, doubt, antagonize instinct in many ways, and the reasoning processes being the later acquired by all animals are the first to be weakened by age or debility. There can be no such definiteness about the nerve tissues engaged in reasoning processes as in instinctively, automatically performed acts.

An instinct may have its impetus in a brain centre that controls the motions of any particular group of muscles, therefore there can be no special seat for instinct in general but as many different seats as there are brain areas concerned in coördinating the multitude of muscular acts. Reason involves every sense and sometimes controls all voluntary motions, hence its seat cannot be special, and, its operations being general, so must be its functionating mechanism. Furthermore, the more recently formed and less definitely constructed fasiculi and nerve cells are apparently more engaged in reasoning processes than the more fully elaborated and perfected strands for simpler reflex acts, such as are concerned in instinctively performed motions.

70 State St., Chicago.

CATALOGUE OF THE SNAKES OF NEBRASKA WITH NOTES ON THEIR HABITS AND DISTRIBUTION.

By W. Edgar Taylor.[1]

The author has published in the proceedings of the Nebraska State Board of Agriculture a complete catalogue of Nebraska serpents including notes and descriptions of the adults and young.[2] Since the preparation of this catalogue Prof. Cope's review of North American snakes has appeared.[3] This together with the fact that the author has had time to review his own studies and add many other notes is sufficient excuse for offering the present catalogue.

In the classification we have followed Prof. Cope.[4]

The notes given are confined to the Ophidia or serpents of Nebraska. The range of the collection, which was quite a large one, included the whole State, and only specimens actually examined by the author are included. Typical specimens have been preserved.

1. Carphophiops vermis Kenn.

Of the habits of this little snake, or of the young, we can say nothing, as we have secured but one specimen within the State. This one was captured at Peru, Nemaha county, by students of the State Normal School. This species is probably not rare, but is protected by its peculiar habits. Dr. Cooper mentions one specimen as collected in "Western Missouri" which term was probably applied to what is now the state of Nebraska.

2. Ophibolus doliatus coccineus Schleg.

This is one of our prettiest snakes, very docile, not often even making an attempt at defense. It seems to feed largely on

[1]State Normal School, Peru, Nebraska.

[2]Ophidia of Nebraska: Report of the Nebraska State Board of Agriculture, 1891. Hon. R. W. Furnas, Secretary.

[3]A Critical Review of the Characters and Variations of the Snakes of North America, by E. D. Cope. Proc. U. S. National Museum, 1892. Vol. XIV, pp. 589–694.

[4]Ibid.

insect larvæ and worms, though the fact that a young specimen thirteen inches in length contained in its stomach a young of *Storeria dekayi* six inches long is sufficient evidence of its disposition to devour other snakes. Many specimens have considerable resemblance to vars. *triangulus* and *gentilis*.

This species is generally distributed, very variable and somewhat common, though not abundant. We have examined specimens from Cuming, Nemaha and Red Willow counties.

3. Ophibolus calligaster Say.

These snakes are quite abundant and similar in habits to *Pityophis sayi*. They are very quiet, often found around lumber, sidewalks, buildings, etc., where they go in search of their favorite food, such as mice, young gophers, etc. While we have found bird eggs, usually the eggs of the Towhee, Cowbird, Woodthrush, etc., indicating that these eggs were found on the ground, and other food in their stomachs, yet this snake feeds largely on destructive rodents. When frightened it often vibrates its tail similarly to the *Bascanium constrictor* and *P. sayi*.

We have examined specimens from Lancaster and Nemaha counties.

4. Ophibolus getulus sayi Holbrook.

We have seen but two specimens of this snake in Nebraska, one collected in Nemaha county and the other in Lancaster county. Mr. Lawrence Bruner informed the author that he collected a specimen near Kearney. This indicates a general distribution, though this species is probably at no point common.

5. Diadophis punctatus Linn.

These little snakes are popularly known as young "Blue Racers," and, since they resemble the adult Racers more than the young of the latter do, this belief is not strange. This Ring-necked Snake is rather common and found, usually,

under rocks and in and around old logs and stumps. We have examined specimens from Cass and Nemaha counties.

We have not often been able to determine the contents of their stomachs but their food seems to be, principally, small larvæ, insects and their eggs, etc.

All our specimens possess seventeen rows of dorsal scales and Prof. Cragin reports the same for Kansas specimens.[5]

It would seem that Kansas and Nebraska specimens are peculiar in this respect.

6. Liopeltis vernalis DeKay.

We have examined only ten specimens of this species, all of which were collected in Cuming county by Mr. Lawrence Bruner and are now in the collections of the State University and the State Normal. Dr. Yarrow mentions one specimen taken at "Sand Hill" Nebraska.[6] This species is probably not rare but is greatly protected by its color.

We can say nothing as to their food habits further than that they are probably insectivorous and vermivorous.

7. Bascanium constrictor Linn.

The Blue Racer is our most active and agile serpent; is very abundant and is said to destroy Rattlesnakes. It has the same habit of climbing in bushes common to the Black Racer of the Eastern States. This act it performs seemingly for the purpose of basking, and also, probably, for hunting prey. We have never observed this snake in trees of any size, but have often seen it in bushes and underbrush. It seems to climb by extending its form in a skillful manner over a number of small branches in such away that its weight is distributed, thus enabling it to crawl over the smallest bushes such as the hazel.

This serpent is, also, our most daring species and is commonly believed to chase persons. This it probably does

[5]A Preliminary Catalogue of Kansas Reptiles and Batrachians by F. W. Cragin. Trans. Kan. Acad. Sci., 1879–80; Vol. VII., p, 120.

[6]All references to localities as given by Dr. Yarrow refer to his Check List, 1882.

through mere curiosity or owing to the temerity of the individual, as it invariably flees when given an opportunity. If forced to fight it often indicates its displeasure by rapidly vibrating its tail raised as in the case of the Rattlesnake. When in the leaves a perceptible noise may be made in this way. As is well known this snake is an enemy of numerous small birds, robbing their nests of the eggs or young and greatly frightening the mother bird.

A somewhat careful examination of the stomach contents of numerous specimens shows this snake to be a great insect destroyer, the most common insects found being the grasshopper, dragonfly, etc. Other snakes are also devoured in great quantities; the Eutæniæ being most frequently captured. In the case of eating other snakes their desires seem to be limited by ability to swallow only. We have found in some large specimens garter snakes not less than two feet long.

This species is common and well known all over the State. We have examined specimens from Brown, Cuming, Gage, Lancaster, Nemaha and other counties. Dr. Yarrow mentions specimens as collected at the following points: two from "Platte River," one from "Nebraska" and one from "Fort Kearney, Nebraska," and another from "Western Missouri" (Nebraska). Dr. Cooper also mentions collecting specimens in Nebraska but gives neither numbers nor localities.

Bascanium flagelliforme Catesby.

Mr. Garman gives the range of this snake as "Dakota to Texas and the Pacific Coast" and Dr. Yarrow mentions one specimen taken on "Platte River, Mo." (Nebraska). The extremely large collections we have had at our command would have enabled us to find this species if it were common. But as it is reported on excellent authority we include the species in our catalogue without numbering.

8. Coluber vulpinus Bd. and Gird.

We have collected but few specimens of this species, all these being from Nemaha county. Judging from its distribution in

adjoining States it may be found all over the State, but in small numbers. Mr. Garman gives the locality of the species as from "Massachusetts to Nebraska." The small number we have examined has not enabled us to determine the food of the species.

9. Coluber obsoletus obsoletus Say.

This snake is, perhaps, our most noted and skillful climber, often being found on the limbs of the larger trees with head raised as if viewing the surrounding country. It is said to be due to this fact that it is called the pilot snake. It is one of our most docile serpents, and students have, by tying a string around its neck and thus retaining their captive for further observation, watched it climb the trees on the Normal School campus. This it accomplishes not wholly by winding around the tree, but by curving its body in various directions in order to support its graceful form on the rough projections of the bark. The cause of this wonderful success in climbing may be surmised when we are told that birds constitute its choice food. One large specimen contained in its stomach two fledglings of the downy woodpecker, (*D. pubescens*) large enough to fly, which the peculiar nesting habits of the mother bird had enabled the serpent to capture. However, mice and other rodents are frequently captured.

We have examined adult specimens from Nemaha county where the species is by no means rare, and the young from Nemaha and Lancaster counties. Dr. Yarrow mentions one specimen from "Western Missouri" which term at the time of making the collection, 1853 (?), probably was applied to what is now the State of Nebraska.

10. Pityophis sayi sayi Schl.

This snake, the common western bull snake, is one of our commonest serpents and the largest species found within the State possibly excepting the *C. obsoletus*. They are found throughout the State ; are comparatively docile unless attacked, when, although non-venomous, their great strength and

weight enables them to make a strong defense. We have often kept them for several days in our laboratory. In several instances when allowed to run at large in the room and after having disappeared for several days they were found snugly coiled away in some cupboard or drawer thought to have been out of their reach. When very much agitated and excited the tail is vibrated rapidly, similarly to the rattlesnake. When in a zinc tank about 2x2 feet these vibrations could be distinctly heard some ten or more feet from the tank. When forced to fight these snakes prefer to get against some object, or coil the body around some bush or stake when they can strike a blow sufficient to defend themselves against the attacks of an ordinary sized dog. However, they never fight as long as there is a show for escape as may be seen by tracing them on an open and almost grassless prairie.

The result of the examinations of the stomachs of these snakes shows that their food is almost wholly made up of rodents, most notably ground mice, but also including rats, gophers, squirrels, moles and similar animals. From an economic standpoint this is our most useful snake, destroying more destructive rodents than any other animal with which we are acquainted.

What meager notes we have on their breeding habits show them to be very prolific, thus accounting for the fact that they are still numerous, notwithstanding their wanton destruction in great numbers.

This species is very abundant all over the State. We have examined specimens from Brown, Dawes, Gage, Lancaster, Nemaha, Sarpy, Sheridan and other countries. Dr. Yarrow mentions one specimen as taken in "Nebraska" and three at "Fort Kearney, Neb."

11. Heterodon platyrhinus Latreille.

These snakes are quite common, seemingly more frequent in eastern Nebraska. They feed almost wholly on insects, insect larvæ and worms, and are always found in a good condition—generally fat—and, furthermore, are certainly worthy of protection, being entirely harmless.

We have examined specimens from Cuming, Gage, Lancaster and Nemaha counties, and Dr. Yarrow reports one specimen from Nebraska. Seemingly displaced in western Nebraska by *H. nasicus nasicus.*

12. Heterodon nasicus nasicus Bd. and Gird.

These snakes are common in the middle and western part of the State, especially in the Sand Hills. We have examined specimens from Cuming, Dawes, Sheridan and Red Willow counties, and Dr. Yarrow mentions two specimens from Nebraska, four from the Platte River and one each from South Platte and the Sand Hills.

Food habits similar to *H. platyrhinus.*

13. Eutænia proxima Say.

The food of this snake consists mostly of insects and their larvæ, but also includes small fish, frogs, etc.

The species is common but nowhere abundant. We have examined specimens collected in Nemaha, Saline and Saunders counties.

14. Eutænia radix Bd. and Gird.

This pretty snake is found all over the State and in food habits agrees with specimens of *E. sirtalis* of the same size. Earthworms and insect larvæ seem to constitute the bulk of its food.

We have examined specimens from Cuming, Dawes, Lancaster, Nemaha and Sheridan counties. Dr. Yarrow reports one specimen from Nebraska and another from Platte River, Mo. (Neb.).

Form *E. r. twiningii* is found over the whole State but is most typical in northwestern Nebraska.

15. Eutænia elegans vagrans Bd. and Gird.

The food habits are similar to other garters of their size. This variety is generally distributed but nowhere common.

We have collected specimens from Gage, Nemaha and Sheridan counties. Dr. Yarrow reports one specimen from North Platte, Neb., one from Platte River, Neb., and two from Nebraska.

16. EUTÆNIA SIRTALIS SIRTALIS Linn.

Food and other habits similar to var. *parietalis.*[6]

We have collected specimens from Brown, Dawes and Nemaha counties. Dr. Yarrow reports one specimen from Nebraska and another from Western Missouri (Nebr).

16 a. EUTÆNIA SIRTALIS DORSALIS Bd. and Gird.

Food and habits similar to var. *parietalis.* Common in the western part of the State. Specimens were collected in Dawes and Sheridan counties.

Dr. Yarrow reports one specimen from Platte River, Mo. (Neb.).

16 b. EUTÆNIA SIRTALIS OBSCURA Cope.

Food and habits similar to var. *parietalis.* Common in the western part of the State; probably the most common variety in southwest Nebraska. We have examined specimens from Brown, Dawes and Sheridan counties. Dr. Yarrow mentions four specimens from Fort Kearney, Neb.; five from Platte River, Neb.; two from Nebraska; two from Missouri River, Neb.; one from Southern Platte, Neb; four from Platte River, Neb.; three from Republican River, Kansas or Nebraska.

16 c. EUTÆNIA SIRTALIS PARIETALIS Say.

This variety is very common in eastern Nebraska but is largely displaced is the western part of the State by vars. *dorsalis* and *obscura.*

[6]Eight specimens which were supposed by us to represent vars. *sirtalis* and *parietalis* were classified by Prof. Cope as "*E. sirtalis sirtalis* an approach to *sirtalis parietalis* in red color tints." The author is inclined to believe that all Nebraska varieties of *E. sirtalis* should be classified as one, notwithstanding great variations. There are a number of forms but all intergrade so as to hardly allow even varietal distinctions.

The full grown specimens of this snake feed largely on frogs, their stomachs often containing two and even three specimens of the full grown leopard frog (*R. virescens*). On one occasion we observed a member of our excursion party immediately after capturing and encaging a large specimen of these garters make a test of its appetite. It voraciously and in succession swallowed three large specimens of the common leopard frog. The snake still seemed anxious for more frogs, but the cries of the latter and the pleading of the young ladies, members of the class, caused the said young man to cease his experiment.

A very peculiar feature of their food habits consists of the fact that specimens of this garter not exceeding two and one-half feet in length almost invariably contain within their stomachs specimens of the common earthworm. Often their stomachs are filled. Other varieties of this species as well as *E. radix* possess the same food proclivities. The manner of capturing these worms would certainly be interesting. We have examined specimens from Cuming, Nemaha and Saunders counties. Dr. Yarrow mentions one specimen from Republican River, Mo. (Nebr.).

17. Natrix leberis Linn.

This beautiful snake is one of our commonest serpents and is very abundant around sloughs and stagnant waters. We have more frequently found this specimen in muddy wet grounds than in the water. This fact, together with the shape of its body and head and the fact that crawfish seem to constitute its principal food has led the writer to think that perhaps this snake is an expert at pulling the crawfish out of the holes made by these forms. We have found as many as five and six crawfish in one stomach and have never found other substances excepting insect larvæ and masses indistinguishable.

We have examined specimens from Gage, Lancaster and Nemaha counties.

18. Natrix fasciata sipedon Linn.

This snake is extremely sluggish, very ill-tempered and unpleasant to handle. Often when brought into our laboratory after being agitated they emitted a very offensive, strong odor which could be detected anywhere within the room. They are very abundant in streams and stagnant waters and are usually found in brush or drifts.

Our specimens are not the typical *sipedon*, but partake partly of the characteristics of both var. *rhombifer* and var. *erythrogaster*. We suspect that the same conditions are true of Kansas specimens since Prof. Snow reports var. *rhombifer* and Prof. Cope var. *erythrogaster*, while the species *sipedon* is also reported by various persons. The reputation of this species for variability is fully sustained in Nebraska—our collection showing specimens of all known shades and distinctness of markings. As in other sections of the country these snakes though harmless are commonly regarded as venomous.

We have examined specimens from Cuming and Nemaha counties. Dr. Yarrow reports one specimen from Nebraska.

The food of this serpent consists almost wholly of water insects and their larvæ, crawfish and fish, being the most fish-loving of all our species. Often the stomach is completely filled with parasitic worms which belong to the class of "round worms" (Nemathelminthes).

19. Storeria dekayi Holbrook.

The contents of the stomachs of these little snakes indicate that they are almost wholly insectivorous. Furthermore the small numbers collected by amateurs, notwithstanding the fact that they are common, shows that their color is a great protection. Also their protective coloration is aided by the dilatation of the body and a disposition to remain very quiet until discovered, these three facts thus showing beyond question great powers of mimicry. Furthermore when the body is dilated the colors are made more grass-like by the exposure of the dingy, dirty edges of the dorsal scales.

We have examined some twelve or more specimens collected in Nemaha and adjoining counties.

20. Crotalophorus catenatus catenatus Raf.

This massasauga or prairie rattlesnake is common in eastern and middle Nebraska though we have not found it in the extreme western part of the State. We have examined specimens from Gage, Lancaster and Nemaha counties, and Dr. Yarrow mentions one specimen as from Nebraska.

We have often kept this snake encaged in our laboratory but have never succeeded in getting them to eat. They seem to prefer to remain coiled in some dark corner of the cage seemingly awaiting an attack.

The contents of the stomachs of this species show that its food is almost wholly made up of mice and other rodents. Aside from well-known venomous qualities this snake has no bad habits and is decidedly useful. It is said that rats or mice will very soon disappear when the presence of this reptile is known. In at least one instance we have known this statement to be true. It was noticed that rats which a few days previous had been extremely numerous in a cellar had almost wholly disappeared. Within a few days the mystery was solved by finding a huge rattler in the doorway. These facts fully account for the frequent finding of the rattler around old cellars, buildings, etc., where they go to find their choice food.

21. Crotalus confluentus confluentus Say.

This species was formerly abundant all over the State, but is now confined almost wholly to the middle and western part of the State, where they are by no means rare. We have examined specimens from Dawes, Hamilton and Sheridan counties. Dr. Yarrow mentions collections made at Pole Creek, Neb., Sydney, Neb., and Fort Kearney, Neb.

Their food habits are similar to *C. catenatus.* This is the species often found in or around the homes of the prairie dogs, where they are most abundantly found during the breeding season of the dogs.

EDITORIALS.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

—The elements are accumulating at Lincoln, Nebraska, for a rather complicated educational puzzle. The State University was established here some twenty odd years ago. Since that time the State has treated it liberally, and some five or six years ago, under the careful guidance of Dr. Bessey, it ceased being a plaything of sectarian plans and came rapidly forward until it stands to-day one of the strongest institutions of learning in the west. In all future educational matters it will be an important factor. Within recent years Lincoln has developed a regular craze for "University" building. Simply to "boom" real estate, colleges are constantly being founded in the immediate vicinity of the city, it being a poor year which does not see the installation of a new "University" in Lincoln or its suburbs. At last information (now three weeks old) Lincoln had, besides the State University, the following other institutions of so-called higher education: Nebraska Wesleyan University, Cotner University, Union University (we thought the Schenectady institution had the copyright on that name) Normal University, Western Normal College and an Episcopal College, the name of which is not at hand. Six institutions, not one of which can maintain a decent college course, to say nothing of making University pretensions. Land speculation and sectarian pride are responsible for their existence. From the educational standpoint they are entirely uncalled for.

As to their future it would seem as if one or two things could occur. They will either drop absolutely out of existence, or they will develop into fitting schools for the stronger and better endowed State University or for denominational schools in other places. At first sight one would think that there would naturally come about affiliation and union; a development of each in its own line. But apparently not. Denominational pride, and more probably conscious incompetence will prevent any mixing, any exposure of the young to the knowledge that they are receiving the veriest sham under the name of a college education.—K.

General Notes.

GEOLOGY AND PALEONTOLOGY.

Geological Survey of Missouri.—Mr. Arthur Winslow the State Geologist makes the following report of progress during the month of April to Governor Francis as President of the Board of Managers of the Department of Geology and Mines of Missouri: Early in the month field work was actively resumed. The examination of the zinc and lead deposits was taken up in Jasper and Newton counties, and detailed mapping is now in progress there. Examinations of iron ores have been made in Stoddard, Dent, Callaway, Cooper, Saline, St. Clair, Butler and Wayne counties. Field work on the clay deposits has been continued in St. Charles and St. Louis counties. In the office the proofs of the engraved Higginsville sheet and of the accompanying report have been corrected, and good progress has been made in the preparation and revision of the report on the mineral waters, the report on the iron ores and the report on the paleontology of the State.

For May Mr. Winslow makes the following report:

Much attention has been given to the study of the zinc and lead deposits and in this connection examinations have been made in Jasper, Newton, Lawrence, Greene and St. Francois counties. In addition detailed mapping has been prosecuted in Jasper county and about 140 square miles have been covered during the month. Further, there has been collected in Jasper county a large number of charts, showing the location of mining properties, shafts and ore bodies, and a great amount of statistical matter relating to these. The material thus acquired will be used in the preparation of the general report upon the zinc and lead deposits and also in the special report which will accompany the maps of Jasper county now being prepared. In connection with the examination of the iron ores stratigraphic studies of the Ozark region have been prosecuted along the Big Piny and Gasconade Rivers, in Texas, Pulaski, Phelps, Maries, Osage and Gasconade counties. In addition iron ore deposits have been inspected in Ripley, Carter, Wayne and Butler counties. The clays of the State have been subjects of further examination in both the field and the laboratory, deposits having been visited in St. Louis, Jefferson, Wash-

ington, Madison, Bollinger, Carroll, Chariton and Randolph counties. The study of the Quaternary geology of the State has been prosecuted in Jackson, Lafayette, Johnson, Macon, Randolph and Saline counties. In Greene and Polk counties a small amount of systematic geological mapping has been done. The excessive rains during the month have not only made all the field work difficult and disagreeable, but have made certain work impossible and have materially retarded the progress in other directions. It is greatly to the credit of the assistants of the Survey that, notwithstanding the hardships endured and the difficulties overcome, such advance has been made. In the office the preparation of reports has been constantly in progress. This includes the original composition, the revision and preparation for the printer, the correction of proof, the drawing of maps and illustrations. The reports which have thus specially received attention during the past month are the report on the Iron Ores, the report on the Mineral Waters, the report on Palaeontology, the report on the Higginsville sheet, the reports on the Warrensburg, Iron Mountain and Mine La Motte sheets and the report on the Crystalline Rocks.

For June the following report is made:

The excellent weather which has prevailed since the early part of the month has much facilitated the progress of work in the field. Zinc and lead deposits have been examined in Franklin, St. Francois, Madison, Washington, Crawford, Jasper, Lawrence and Newton counties; about 110 square miles have, in addition, been mapped in detail in Jasper county. Clays have been examined in Adair, Randolph, Warren, Montgomery, Audrain, Jackson, Lafayette, Saline, Howard, Callaway, and Pike counties. Iron ores have been inspected in Mississippi, Dunklin, Scott, Ripley, Butler, Carter, Shannon, Howell, Oregon and Ozark counties and the stratigraphy of the country along Current river has been studied in connection with these deposits.

The mapping of the crystalline rocks has been resumed in Wayne, Iron and Reynolds counties. The study of the Quaternary formations has been prosecuted in Saline, Howard, Boone, Callaway, Montgomery, Warren, Ray, Macon and Randolph counties and the terminal line of the drift has been traced almost entirely across the State.

In the office the preparation of the reports on the iron ores, on the zinc and lead ores and on the paleontology has continued and the manuscript of the report on the mineral waters has nearly all been transmitted for revision and preparation for the printer; the Higgins-

ville map and section sheet and the accompanying report have been printed and will soon be ready for distribution.

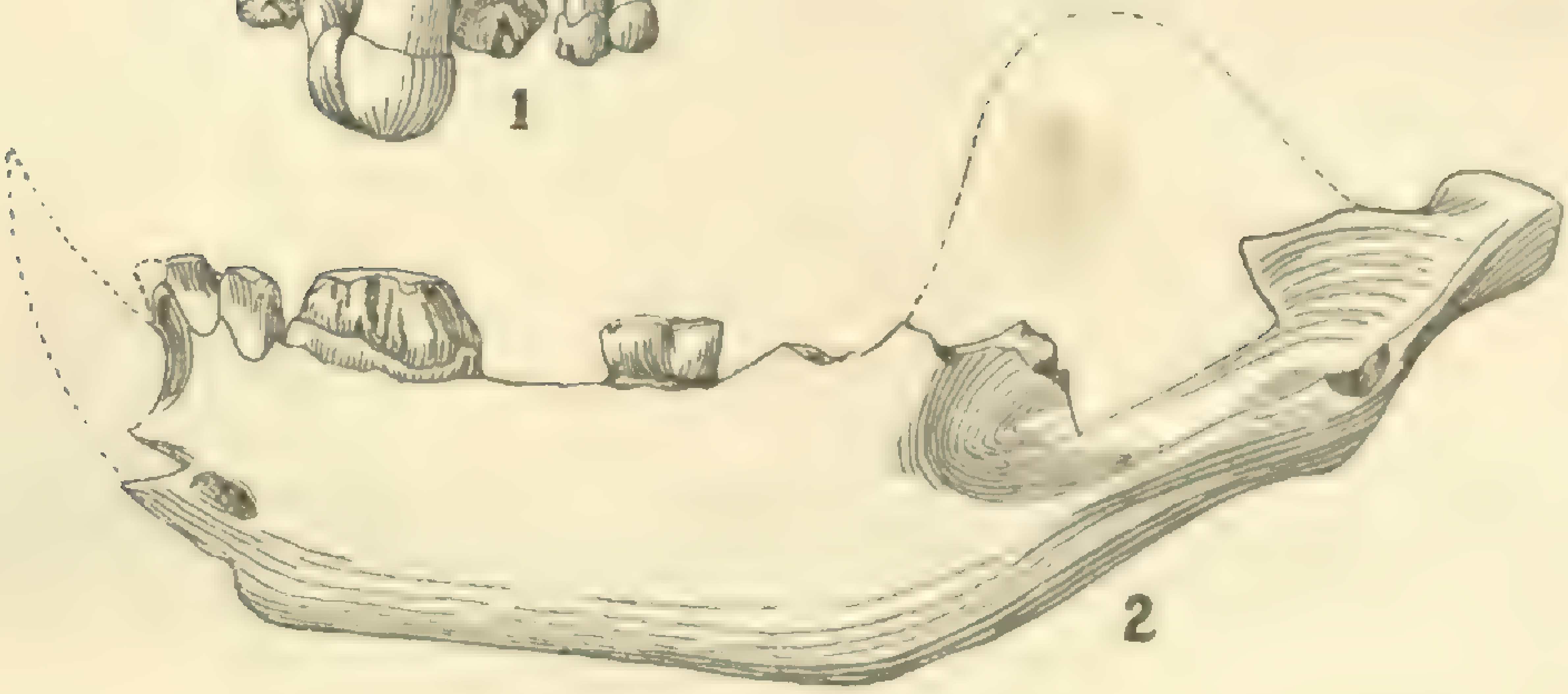
During the past month, arrangements have been perfected for intimate cooperation between the World's Fair Commission and the Geological Survey, such that the material accumulated and the great amount of knowledge acquired by the latter organization concerning the geology and the mineral deposits of the State will be applied in the interests of the prospective exhibit in Chicago. The plans adopted and the progress already made in the execution of these plans yield abundant promise that the display in this department will be of the greatest possible credit and advantage to the State.

The Pacific Cable Survey.—The United States steamer Thetis has been making a second survey for the proposed cable between San Francisco and Honolulu, and met with far greater success than was had in the first survey, made by the steamer Albatross six months ago, when the line of survey was from a point on Monterey Bay, direct to Honolulu. The Thetis made a start from Point Conception, 220 miles south of San Francisco and thirty-eight miles west of the town of Santa Barbara, and at the head of Santa Barbara channel. At the point there is high ground and the water shoals off on a mud bottom. As a landing place for a submarine cable everything is favorable. The course taken by the Thetis was nearly due southwest and by way of the great circle. Soundings were made every two miles until 900 fathoms was reached. As the steamer proceeded toward the Hawaiian islands the depth of water gradually increased until 3000 fathoms was averaged for miles. Soundings were taken at intervals of ten miles where the bottom was found of a level nature and where irregular or undulating at distances down to half a mile. The greatest depth reached was 3228 fathoms when about 300 miles from Hilo on the island of Hawaii, which is marked as the landing-place at the islands. Thirty-five miles from Hilo the water shoaled to 1000 fathoms, and from that gradually on to twenty fathoms. There is more water at Hilo than at Point Conception. The island of Hawaii is about 200 miles southeast of Honolulu and can be connected by a short cable. By the Thetis survey the cable will run 2060 miles. The Albatross survey is about fifty miles longer, but not quite as practicable owing to the bottom of the sea being very irregular over a greater part of the first survey.

Fourth Note on the Dinosauria of the Laramie.—Previous notes on this subject have appeared in the NATURALIST for 1888 p. 1108; 1889 p. 715; and 1889 p. 904. In the present communication

PLATE XXII.

1



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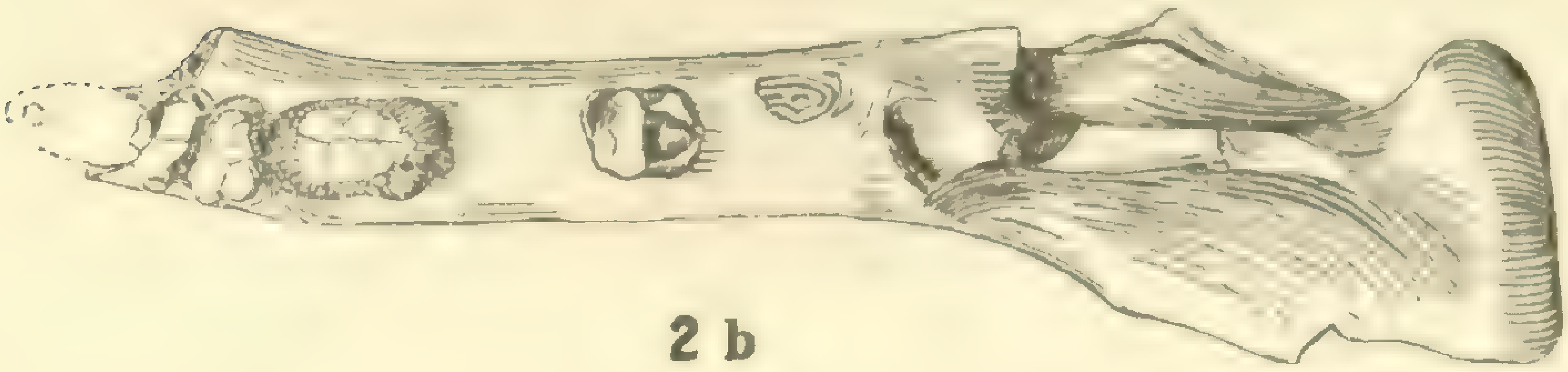

2 b

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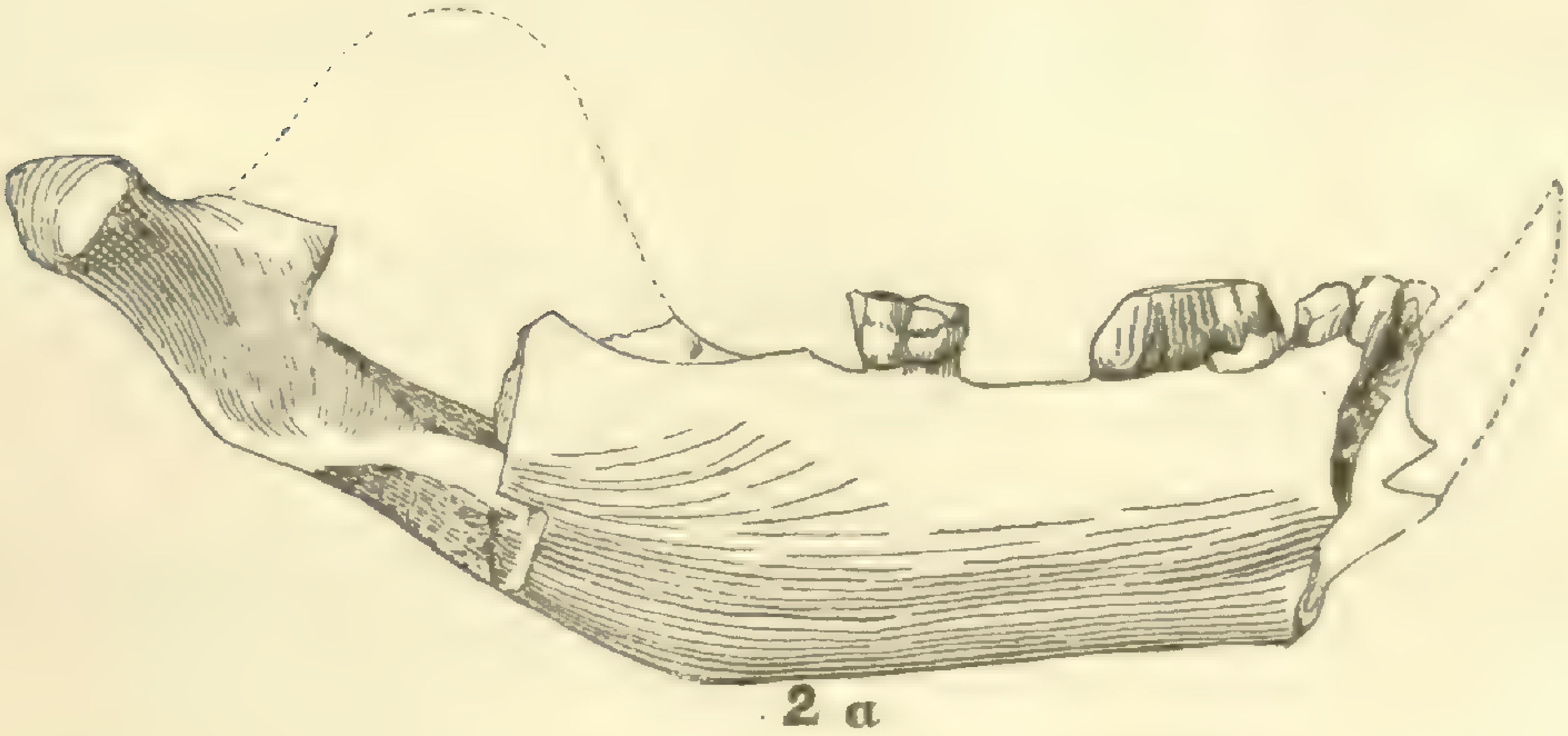
1 a



2 a

Thlæodon padanicus, COPE.

two additional forms are describéd, and rectifications of synonomy are made.

Manospondylus gigas.—Gen. et sp. nov. *Char. Gen.*—Dorsal vertebræ with short anteroposterior diameter, and gently concave articular faces. Neurapophyses coössified. At the superior part of the centrum, a deep entering fossa ; surfaces of circumference otherwise uninterrupted. Tissue of centrum at borders of articular faces coarsely vesicular. The form of these vertebræ indicates that this genus is allied to the Agathaumidæ rather than the Hadrosauridæ. No genus of either family known to me possesses the fossæ at the base of the neural arch.

Char. specif.—Dorsal centrum a little deeper than wide. Lateral surfaces smooth.

Diameters of centrum.		mm.
Articular face	vertical	205
	transverse	200
Anteroposterior		90

Two dorsal vertebræ are the only remains which I can refer to this species, which is the most gigantic of the Dinosauria of the Laramie known to me. In the same neighborhood, but several hundred yards distant, I discovered a huge supratemporal bone, which differs from those of some of the allied genera in having a simple undulate free border, without tuberosities or processes. Its form is similar to that of Agathaumas, *i. e.* as broad as long posterior to the quadrate suture. There is no evidence that it belongs to this species.

Claorhynchus trihedrus.—Gen. et. sp. nov. *Char. Gen.*—This genus is established on a rostral and predentary bones of a species of the Agathaumidæ, which were found together and with the fragments of a massive supratemporal bone. They are distinguished by their absolutely flat inferior faces, there being no alveolar ridges as in the forms described by Marsh. They are not compressed but are as wide as long. They are not adapted to the muzzle of Monoclonius, where the rostral bone is compressed. (*M. sphenocerus.*)

Char. specif.—Rostral and predentary bones as wide as long, with flat inferior face and rounded superior median angle. Transverse diameter rather exceeding the vertical. Sides convex. All the surfaces furrowed by coarse grooves which terminate in foramina.

The short wide form of this species differs from that seen in the species of the family Agathaumidæ which have been yet described.

The extremity of the beak had apparently a horny sheath and was adapted for crushing comparatively hard substances.

Agathaumas Cope—Professor Marsh (Amer. Journ. Sci. Arts, 1892, p. 83) endeavors to show that this genus differs from any of those described by him by quoting characters from my description of the type specimen. Since my last description of that genus was published (1875), I have studied part of a skeleton obtained by Dr. J. L. Wortman in Dakota, of which the parts are undistinguishable from those of the *Agathaumas silvestre*. These include an ilium in much better preservation than that of the type, and I am enabled to correct some of the statements contained in my original description. I stated that there is no facet for the pubis at the front of the acetabulum. The surface at this point is broken in both of my specimens, but it is altogether probable that the structure at this point does not differ from that of the allied forms. The ischiadic suture is in like manner obscured by injuries in the type specimen. The Dakota specimen is perfectly preserved at this point, and displays a large convex sutural surface for the ischium, thus showing that my original description was imperfect in this point. The number of sacral vertebræ in the original specimen is not exactly determinable—only approximately, but this region is identical in character with that of other members of the family. That the *Agathaumas silvestre* is one of the largest species of the family is indicated by the following measurements of the Dakota specimen:

		mm.
Length of ilium		1465
Length of tibia		940
Diameters of tibia	greatest proximal	325
	greatest distal	290
Diameters of dorsal centrum	anteroposterior	95
	vertical	138
	transverse	137

The centrum of the dorsal vertebra is slightly opisthocœlous.

Pteropelyx Cope—This genus was described by me in The American Naturalist for October, 1889 p. 904 (published March 5th, 1890), It has been subsequently named by Marsh, Claosaurus, in the American Journ. Sci. Arts. for May, 1890 (p. 423).—E. D. Cope.

On a New Genus of Mammalia from the Laramie Formation.—In 1881 I had the pleasure of announcing the existence of Mammalia in the Laramie formation, and described the new genus

and species of Multituberculata, *Meniscoëssus conquistus.* Since then Prof. Marsh has described several species from the same formation, exaggerating the number very considerably, as has been precisely shown by Prof. Osborn. I now introduce to notice another species, which represents a new and peculiar family of Marsupialia or Monotremata, and which throws considerable new light on some of the species described by Prof. Marsh. The material in my possession consists of a mandibular ramus of the left side which is nearly complete, and which contains three premolars with alveoli of the anterior premolar and canine, and a fragment of the last true molar; with another true molar. About one hundred feet from this specimen was found a part of the right maxillary bone containing an entire last premolar with parts of the penultimate premolar, and first true molar; a molar lacking the protocone was found close to this fragment, and evidently belongs to it. So close is the resemblance in character between the teeth of the two jaws, that I am satisfied that they belong to the same species, and probably to the same individual.

THLÆODON PADANICUS.—Gen. et. sp. nov. *Char. Gen.*—Dental formula, I. $\frac{?}{?}$; C $\frac{?}{1}$; P. m. $\frac{?}{4}$; M. $\frac{?}{3}$. Inferior canine robust, one rooted. Premolars $_{1234}$ two-rooted; $^{1-2}$ three-rooted. Posterior premolar each jaw with robust, convex, swollen crowns, without heels or accessory cusps. Superior true molar tritubercular, with large internal cusps, and small external cusps; intermediate cusps present. Inferior premolars 2–4 with transverse crowns. Inferior true molar with anterior trigon and posterior basin; the former transverse, the latter with posterior angular cusps.

The genus Thlæodon represents apparently a new type of Marsupialia, or possibly of Monotremata. In the entire absence of the mandibular angle it resembles Ornithorhynchus, and also the genus Triconodon Owen, and several other genera of the Jurassic system. It differs from most of the genera of the Jurassic non-Multituberculata, in the normal number of its teeth, which apparently agrees with that typical of the class; viz. I. 3; C. 1; Pm. 4; M. 3. The number of true molars may be four, but the space which is preserved in the lower jaw is as appropriate to three; either number requiring that the teeth should present somewhat unequal dimensions. The form in any case indicates an ancient and inferior type, specialized in the direction of dental reduction, and in the development of a molar or crushing type of premolars. The true molars are also specialized in the direction of modern forms, the superior being tritubercular, and the inferior

quinquetubercular, with trigon and heel. The genus may be referred to a new family, the Thlæodontidæ, with the following definition. Mandible without angle, but with inflected inferior border, and a coronoid process. Molars $\frac{3}{5}$-tubercular; premolars simple. Canines well developed; incisors reduced.

The discovery of this genus enables me to suggest a further reduction on the number of genera named (but not described) by Prof. Marsh. It is now indicated that the forms with only the simple and robust premolars which have been described by Marsh under the name of Stagodon, belong to the animals of which molars only are described under the names of Didelphops, Didelphodon, etc., and should be referred to identical genera and species. What the simple-rooted tooth which served as the type of Marsh's Stagodon really is, remains to be ascertained, but some of the premolars of Mammalia described by him under that name resemble those of Thlæodon, although much inferior in size and less robust than are those of *T. padanicus*. The largest species described by Marsh, under the name of *Stagodon validus*[1] is not very different in size from the *T. padanicus*, but the number of premolars is probably smaller, or if equal, the anterior ones are longitudinal and not transverse. The description of Marsh is valuable as indicating the character of the incisors, a point not elucidated by my specimen. Marsh refers these forms to a family Stagodontidæ[2] which he does not define; moreover the generic character of the real Stagodon remains undescribed.

The widely transverse condyle of Thlæodon shows that the movement of the lower jaw in mastication was vertical or orthal, as in the opossums, and not propalinal as in the Multituberculata, or loose as in the modern Monotremata. The true position of the family must, however, remain doubtful until other portions of the skeleton are discovered. The genus Thlæodon may be simply a form of Didelphyidæ with simple robust premolars.

Char. specif.—The surface of attrition of the superior premolars is oblique to the vertical axis of the crowns, the latter spreading outward and downward in relation to the maxillary bone. The crown of the first premolar is very much larger than that of the second, and is subquadrilobate. This form results from the presence of three grooves which rise from the interradical spaces, but which do not attain the summit of the crown. The latter is obtusely rounded, with the anteroexternal diameter in excess of the anterointernal diameter.

[1]Amer. Journ. Sci. Arts, 1889, August, p. 178. Pl. vii, figs 22–5.

[2]Op. cit. 1892, March 256. Pl. viii, fig. 7.

The enamel is coarsely wrinkled when not worn by use. The roots are encased in a layer of cementum, which forms a narrow ledge round the base of the crown. The true molar preserved has a transverse triangular crown. The paracone is conical and the metacone is compressed so that its worn section is anteroposterior. A longitudinal ridge notched in the middle occupies the space between the paracone and metacone. The protocone is represented by a large worn surface, whose interior extremity is unfortunately broken away. The paraconule forms a narrow transverse crest which passes in front of the paracone. The metaconule on the other hand is within and anterior to the metacone.

The alveolus is all that indicates the character of the inferior canine. It is deep, extending to the base of the ramus, and is directed with a straight axis, a little forward of upward. The side is longitudinally keeled near the fundus on the external side. The anterior three inferior premolars are very narrow, extending transversely across the alveolar line, with divergent roots. The crowns are so worn that their structure is not determinable. The first inferior premolar, is very robust, its crown equaling those of the other three in anteroposterior diameter. The horizontal section of the crown is a longitudinal ovoid. The anterior border is broadly rounded ; the posterior bilobate, the internal lobe more prominent than the external. There are two roots, of which the posterior is grooved on the internal side, giving the appearance of three roots, a form to which the alveolus is adapted. Two grooves rise from these grooves on the inner side of the crown, and there are two or three obscure grooves on the external side. Enamel rough. Roots with cementum layer, which forms a narrow ledge round the base of the crown. Like the superior true molar preserved, the inferior truemolar is remarkable for its small size as compared with the premolars. It is of robust form, presenting anteriorly a transverse trigon, which is worn to a uniform surface in the specimen, but displays traces of the paracone and metacone. A strong cingulum marks the external part of the anterior base of the protocone. The heel is short and wide, and has a raised border surrounding a basin. The border consists of external and internal compressed cusps, and a small median one soon confluent with the internal one. No cingula other than the one described. The last inferior molar has left only the base of its heel, which was evidently more elongate than that of the other molars. The coronoid process has a base much extended anteroposteriorly ; it is broken off. The masseteric fossa has a strong anterior rib border, but the inferior border is very promi-

nent, being a horizontal ledge extension of the inferior face of the ramus, which rises gradually to the internal extremity of the condyle. The condyle is unusually extended transversely for the size of the ramus; the extension being principally external. The internal inflection commences below the posterior base of the coronoid process and its border extends diagonally inwards and anteriorly. It bounds a large dental foramen and canal.

Measurements.		mm.
Length of ramus from canine alveolus to and including condyle		75
Length from last true molar to and including condyle		37
Length of inferior premolar series		17
Diameters of last premolar	transverse	6
	anteroposterior	8
Diameters of true molar	transverse	4.5
	anteroposterior	5
Depth of ramus at premolar 1		15
Depth of ramus at molar 3		16
Transverse diameter of condyle		16
Diameters superior premolar 1	transverse	8
	anteroposterior	7
Anteroposterior diameter true molar ? 2		5

The jaws are about the size of those of the gray fox, *Vulpes cinereoargentatus.*

Prof. Marsh (Amer. Jour. Sci. Arts, March, 1892, p. 251) regards the fauna of the Laramie as widely different from that of the Puerco, which succeeded it. He says "the more the two are compared the stronger becomes the contrast between them." It is true that no Ungulata have been yet found in the Laramie, while they abound in the Puerco, but we cannot be sure that they will not yet be found; the probabilities are that they existed during the Laramie, and that it is due to accident that they have not been obtained. But the Multituberculata of the two faunæ are much alike. Thus the *Dipriodon lunatus* (Marsh l. c., Pl. v, fig. 7,) appears to be a species of Ptilodus Cope, and the *Cimolodon nitidus* (l. c. vi, fig. 9,) is either a species of that genus or of Neoplagiaulax Lem., both genera characteristic of the Puerco.

Explanation of Plate.

All the figures natural size.

Fig. 1. Fragment of maxillary bone external view: 1 *a* internal view; 1 *b* inferior view.

Fig. 2. Left mandibular ramus external view: 2 *a* internal view; 2 *b* superior view.—E. D. Cope.

What is Lophiodon?—Under this generic head the French, German and Swiss palæontologists have gathered a number of very diverse types of molar teeth. In the recent memoir[1] of Prof. Rütimeyer upon the Fauna of Egerkingen and his earlier memoir[2] we find a series of beautiful figures in which the distinctive characters are very clearly brought out. They leave little doubt in my mind that the genus *Lophiodon* which has long been a sort of corral for all the fossil lophodont perissodactyls of Europe, in which the premolars are not like the molars, should be split up not only into a number of genera, but that these genera should be placed in a number of distinct families. This union of these forms under one genus, has been a natural result of the isolated condition in which the types have been found and the re-determination of these forms is only rendered possible by the complete series of upper and lower teeth which are now found in the Eocene.

I am not at present in a position to attempt to review these forms thoroughly for I have not at hand the types, nor all the early literature, nor the recent memoir of M. Filhol.[3] I merely offer a few preliminary notes, availing myself of the admirable figures and descriptions of Rütimeyer.

Turn first to Prof. Rütimeyer's later volumes:

The references are to his plates. *Lophiodon annectens* Rütimeyer, (Taf. I, fig. 12–13). These molars have the same characteristics as those of the primitive Tapirs, and bear a most striking resemblance to those of *Isectolophus annectens*[4] from the American Eocene; this resemblance extends not only to the relations of the cusps and crests but to the development of a complete cingulum around the crown.

Lophiodon cartieri Rütimeyer, (Taf. I, fig 12). The characteristics of this type (Fig. 10 *b*) are that the protoloph springs from the paracone, the metaloph rises from a point slightly in front of the metacone, the paracone is conic while the metacone is slightly flattened upon the outer surface, the parastyle is low, the cingulum is feebly developed below the paracone. These are the characteristics of the series to which *Heptodon* Cope and *Helaletes*[5] Marsh belong. The premolars

[1] "Die Eocäne Säugethier Welt von Egerkingen," Zurich, 1891.

[2] "Eocæne Säugethiere aus dem Gebiet des Schweizerischen Jura," 1862.

[3] Filhol. "Vertébrates fossiles d'Issel," Mém. Soc. Géol. de France. 1888.

[4] See Osborn, "Mammalia of the Uinta Formation," Plate X, fig. 1.

[5] *Desmatotherium* Scott is a synonym of Helaletes. See Bull. No. 3, E. M. Museum, 1883, Plate viii, fig. 3.

referred by Prof. Rütimeyer to *L. annectens* are very similar to those of *H.* (*Desmatotherium*) *guyotii* Scott, from the Bridger Eocene.

Lophiodon isselensis Fischer, (Taf. I, fig. 9). This is a distinct type. The figure agrees closely with that given by Gaudry[6] of a complete series of upper molars. This exact type of molar has not been found in America. So far as known the true *Lophiodon*, like *Palæotherium*, was confined to Europe. The characteristics of this *Lophiodon* molar are that both paracone and metacone are conic and nearly of the same size, in this respect it resembles the Tapir, but it differs widely from the tapir in the origin of the transverse crests, for the protoloph passes up to the paracone and the metaloph springs from the metacone, whereas in the Tapir these crests spring from the anterior base of the external cusps.

Turn now to Prof. Rütimeyer's earlier volume:

Lophiodon rhinocerodes Rütimeyer, (Taf. I, fig. 4). The type molar of this species is, as the name implies, of the true rhinocerotine pattern. It is closely similar to the first upper molar of *Amynodon* (*Orthocynodon*) *antiquus* from the upper division of the Bridger Eocene, as figured by Scott and Osborn,[7] except that the tooth is much larger and the parastyle is more prominent. The lower canine is quite different. This form therefore is distinct from *Amynodon* in several features.

Lophiodon tapiroides Cuvier, (Tab. II, figs. 15–26). The first and second molars have nearly the true tapir pattern. The protoloph joins the robust parastyle. The metaloph rises half way between the paracone and metacone. The third molar, however, is not tapirine for the ectoloph is abbreviated as in the rhinocerotine type, in *L. isselensis*, and in *Heptodon*.

Lophiodon parisiensis Gervais, (Tab. III, fig. 27–35). This molar has no exact counterpart in the American Eocene.

Lophiodon cartieri Rütimeyer, (Taf. III, fig. 38–40). These molars are precisely similar to those of the middle sized *Hyrachyus*, *H. agrarius* of the Bridger Eocene.

Egerkingen, Species.	Bridger, Nearest Allied Form.	Family.
L. annectens	Isectolophus annectens	Tapiridæ
L. cartieri	Hyrachyus eximius	Hyracodontidæ
L. rhinocerodes	Amynodon antiquus	Amynodontidæ or Rhinocerotidæ
L. isselensis	unique	Lophiodontidæ.
L. parisiensis	"	? "
L. tapiroides	"	"

[6] "Enchainements du Monde Animal," fig. 72.

[7] E. M. Museum Bulletin, No. 3, Pl. V, fig. 2, 1883.

The conclusions here arrived at are: First, that the Egerkingen fauna, which Prof. Rütimeyer has already shown to contain a surprising number of New World forms, embraces also the true *Hyrachyus* and *Isectolophus* types, also a form ancestral to the Rhinocerotidæ. Second that the character of the external cusps and the point of union of the transverse crests with them are so diverse that some of the different species referred to *Lophiodon* probably belong to distinct genera. I find that the forms and relations of these cusps and crests are absolutely constant and distinctive in the families of American lophodonts and it is highly improbable that the single genus *Lophiodon* should embrace *specific* molar types as different from each other as the *family* molar types are in the American Eocone.

The question, what is Lophiodon? is yet to be answered. Where does it stand with reference to the tapirs, rhinoceroses, hyracodonts?—Henry F. Osborn, American Museum of Natural History, New York, July 12th, 1892.

MINERALOGY AND PETROGRAPHY.[1]

Mt. Hekla Liparites.—The material of three new liparite streams from the vicinity of Mount Hekla, in Iceland, and that of the one described by Preyer and Zirkel[2], have been examined by Backström.[3] In all the rock consists of phenocrysts of orthoclase and green pyroxene in a more or less glassy hyalopilitic groundmass without peculiar features. One specimen contained small grains of olivine and another accumulations of tridymite. None of the streams originated at Hekla. Their source is not known. A granophyre from the north coast of the Snäffel Peninsula is mentioned by the same author as containing plagioclase grains, surrounded by orthoclase zones, and these in turn by micropegmatitic intergrowths in which the orthoclase is orientated with the same mineral in the zone around the plagioclase. This and other granophyric liparites in the neighborhood are very similar to the 'Krablite' inclusions thrown out from the crater of Viti. Of the other liparites of different ages described by the author some are trachytic in character and others are granophyric. In discussing their general features Backström separates them into true liparites, liparite glasses and granophyres, composed essentially of feldspars, pyroxene, iron oxides, zircon and glass, to which are sometimes added quartz, tridymite, apatite, olivine and occasionally hornblende, biotite, hypersthene and sphene. The rarity of biotite is notable. Of the feldspars plagioclase was found in every specimen examined and sanidine in but few. Nevertheless the percentage of CaO in the rocks is small. Upon comparison of seventeen analyses of fresh specimens of the Icelandic liparites it is found that the amount of sodium in them exceeds that of potassium, and that in this respect the Iceland district differs materially from that of the Great Basin and of Hungary.

Bostonite and Monchiquite from Lake Champlain.—A recent abstract of a paper on the trap dykes of the Lake Champlain Valley by Messrs. Kemp and Marsters[4] is very interesting, as it makes known the existence there of two rare types of dyke rocks, bostonite

[1]Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2]Reise nach Island. Leipzig, 1862, p. 346.

[3]Geol. Fören. Forh., xiii, 7, p. 639.

[4]Trans. N. Y. Acad. Sci., xi, 1891.

and monchiquite. The bostonite[5] is usually of a creamy or brownish white color. Its structure is typically trachytic, with a few phenocrysts of orthoclase in a groundmass composed of rods of this mineral and of anorthoclase, and between these little masses of quartz. No dark silicates occur in any of the sections examined. An analysis of the rock gave:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Loss	Total.
62.28	19.17	3.39	1.44	tr.	5.93	5.37	2.33	= 99.91

The specific gravity is 2.648. In several places dykes were noted in which the bostonite cements angular pieces of other rocks forming an eruptive breccia. The included fragments are sometimes slate and red quartz that show no effects of contact action, and sometimes rounded masses of norite, quartzite and limestone, whose shapes are due largely to absorption by the eruptive. The monchiquites consist chiefly of zonal augite, brown hornblende and biotite crystals, and olivine in a feebly refractive groundmass that may be an altered glass. The augite and hornblende are in two generations and the other minerals in but one. An analysis of one specimen gave:

SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	Loss	Total
40.37	17.86	14.45	.38	17.61	1.63	.83	1.29	4.47	= 98.89[6]

Besides the two types mentioned there occur also in the region many dykes of diabase and camptonite.

The Serpentine of the East Central Alps.—The serpentine occurrences within a restricted area in the East Central Alps have been examined by Weinshenck[7] with a view to learning something of the origin of the rock. Its irregular masses imbedded in crystalline schists consist of serpentine, talc, etc., that were formed by the alteration of a pyroxenic aggregate. At the contact of the rock with the neighboring schists has been produced a great variety of hornstones, among which may be mentioned garnetiferous and epidotic kinds containing much diopside, vesuvianite, etc. The existence of contact effects around the serpentine and the presence of dykes of the latter rock in the surrounding schists indicate to the author that the mother-rock of the serpentine was an eruptive pyroxenite.

[5] American Naturalist, 1891, p. 573.

[6] Given as 99.39 in original.

[7] Habilitationsschrift. München, 1891.

Petrographical News.—Several banded inclusions from the tonalite of Mte. Aviole in the Tyrolese Alps have yielded Salomon[8] some interesting observations. In one of the specimens one band is composed chiefly of hornblende so filled with elliptical inclusions of quartz, augite and glass that but a mere skeleton of the hornblendic material binds them together. A second band consists largely of augite. The third is principally an intergrowth of quartz and plagioclase in the form of a mosaic, whose particles are polygonal and straight edged. Specimens of contact rocks near the tonalite contain as accessory components sphene, biotite, quartz and zircon. The author calls attention to the peculiar cellular structure of the minerals he describes and asserts that it is a characteristic structure for substances formed by contact action. Aggregates of minerals exhibiting this 'contact structure' he would call contact-amphibolites, contact-gneisses, etc., in accordance with their composition.——In a note on the use of the gold washer's pan as an instrument for the separation of the heavy constituents of sands and decomposed rocks Derby[9] recounts his results of the examination of some granites and gneisses from the United States. In all the specimens examined there were found zircon grains, and these were especially plenty in granites from Otter Creek, Mt. Desert and the Hurricane Islands, in Maine, and from Ilchester, Md., and in the gneisses of Endfield, N. H., and Pascoag, R. I. Monazite is particularly abundant in the granite of Westerly, R. I., and in the gneiss of Randolph, N. H. Xenotime was found in the gneiss of Wessford, Mass., and allanite, rutile and apatite in most of the rocks mentioned. The author thinks that there is a reasonable probability that zircon and monazite may prove to be guide minerals by which eruptive rocks may be detected, however much they may be disguised by metamorphism. The occurrence of these minerals in the crystalline schists is an indication that these rocks are squeezed eruptives and not changed sedimentaries.——The conglomerate of Hoosac Mt., Mass., is overlain by an albite schist whose origin is ascribed by Wolff[10] largely to the replacement of clastic microline grains by albitic substance, with the attendant production of muscovite. Eight excellent figures in the author's article show the transition of decomposed fragments of feldspar into a fresh particle of albite in which all traces of clastic origin have disappeared. The

[8]Neues. Jahrb. f. Min., etc., B. B. vii, p. 471.

[9]Proc. Rochester Acad. Sci., 1, 1891, p. 198.

[10]Bull. Mus. Comp. Zool., xvi, p. 173.

original microline in the schist is often surrounded by a rim of new microline or of albite with the same orientation as the kernel. Arms from this extend into the nucleus, until finally the new material has entirely replaced the old.——In a few notes on some rocks from the Lake District, England, Hutchings[11] mentions briefly the characteristics of a biotite-quartz-andesite, and describes a series of hyalopilitic andesites, and one rock whose chemical composition is that of trachyte, while its mineral components are those of an andesite. He also briefly alludes to an augite porphyrite and a granular diabase.——Another occurrence of peridotite has been discovered in central New York, this time as a small dyke in a fault fissure near Manheim, seven miles east of Little Falls. The rock as described by Smyth[12] consists of phenocrysts of biotite and olivine in a groundmass of glass, biotite, magnetite, perofskite and a fibrous mineral supposed to be microlitic olivine.——Among the eruptive rocks of Flag-staff Hill, Boulder Co., Col., Palmer[13] has discovered quartz porphyries with phenocrysts of quartz, feldspar and black mica in a decomposed microfelsitic base, showing here and there evidences of flow structure. From its analysis the rock seems to be an andesite rather than a quartz-porphyry.——In a recent bulletin Mr. Diller[14] gives a full account of the cone of the volcano that erupted the quartz-basalt described by him a year or so ago, as well as an excellent discussion of the character of its lava.——A granitite from Farérolle in the Puy-de-Dôm, France, contains in addition to its essential constituents fluorite, autunite and torbenite.[15]

Quartz.—At Pitôurees-en-Lordat, France, are beds of dolomitic limestone interlaminated with thin beds of talc schist and cut by veins of quartz in which Lacroix[16] has found some very remarkable twisted quartz crystals. Some of these are simply bent in one plane; others are now spiral, and each seems to have been affected independently of its neighbors. The force that produced the deformation in the shape of the crystals also strongly modified their internal structure, so that sections parallel to *c* show little areas differently orienated like the grains in a quartzite, while in sections perpendicular to *c* uniaxial

[11]Geol. Magazine, 1891, p. 536.

[12]Amer. Jour. Sci., April, 1892, p. 322.

[13]Proc. Col. Sci. Soc., iii, 1889, p. 230, and 1890, p. 351.

[14]Bull. U. S. Geol. Survey, No. 79.

[15]Gonnard, Bull. Soc. Franç. d. Min., xiv, p. 223.

[16]Bull. Soc. Franç. d. Min., xiv, 1892, p. 306.

particles are intermingled indiscriminately with those that are biaxial. On the contact with the veins fine masses of tremolite have been developed in the limestone.——The quartz crystals of Suttrop, Vlotho and Bramsche in Westphalia, and incidentally crystals from other localities, have been thoroughly studied by Bömer,[17] especially with reference to their etched figures and electrical properties. The Westphalian crystals were treated with hydrofluoric acid, and sections cut from them parallel to oP were subjected to the action of the same reagent. The sections were also examined for circular polarization, and the entire crystals for electrical manifestations. The Vlotho and Bramsch crystals, the former of which occur in druses on marl and the latter implanted in white vein quartz in quartzite, are quite simple, while the Suttrop crystals, found loose in the soil overlying a quartzite composed almost exclusively of quartz crystals, are very complicated in structure. These consist usually of two or more individuals twinned, and often intergrown with others in the parallel position. The forms of the etched figures produced on oP vary widely. They depend upon the strength of acid used and upon the temperature at which the action takes place. With increasing strength of acid the figures suffer a rotation around the vertical axes of the crystals, and in the direction of its polarization, i. e. in right polarizing crystals, the rotation is to the right and in left-handed crystals to the left. Many other interesting results in connection with the etched figures of quartz were obtained by the author and some of them contradict the results of other investigators. With reference to the pyro-electrical properties of the crystals it was found that in small ones the negative and positive areas were irregularly distributed, while in large ones the distribution was more regular. Both large and small crystals act similarly when cooled in ether or in water. In each case the trapezohedral edges are positive.

Mineralogical News.—Among the wonderful pseudomorphs of serpentine from the Tilly Foster Mine, N. Y., Dana mentioned a cubic substance whose predecessor was unknown. Friedel[18] has reexamined this substance, and has found in it a central cone of amorphous serpentine, surrounded by a fibrous envelope of the same mineral. The arrangement of the fibres is so regular that the author concludes that the cubic form is due entirely to it, and that there is no reason for supposing the form to be pseudomorphic.——Excellent specimens of

[17]Neues Jahrb. f. Min., etc., B. B., vii, p. 516.

[18]Bull. Soc. Franç. d. Min., xiv, p. 120.

metacinnabarite from New Almaden, Cal., have given Melville[19] an opportunity to measure and to analyze its crystals. The mineral occurs in steep rhombohedral forms attached to quartz crystals, which in turn coat cinnabar crystals, resting in a compact mass of this substance and quartz. The terminations of the crystals are differently modified, the analogue pole containing principally the basal plane and rhombohedra, and the antilogue pole mainly steep scalenohedra. The analysis, made on impure material, gave:

S	Hg	Fe	Co	Zn	Mn	$CaCO_3$	Res.	Org. mat.	Total
13.68	78.01	.61	tr.	.90	.15	.71	4.57	.63	= 99.26

The organic matter was in the form of little black spheres imbedded within the crystals.——If the orthopinacoids of the members of the *heulandite* group be made the orthodome $\frac{1}{2}P\infty$, Rinne[20] shows that its members may be regarded as forming an isomorphous group with stilbite, harmotome and phillipsite. The axial ratios of the various minerals come into accord with this view if half of *c* is taken as the unit in the members of the stilbite sub-group. The chemical composition of the different minerals is also similar enough to oppose no objection to the idea, the stilbites being mixtures of $R'' Al_2 Si_6O_{16} + 6Aq$ and $R_2 Al_2 Al_2 Si_4 O_{16} + 6Aq$, and the heulandites $R Al_2 Si_6 O_{16} + 6Aq$ for heulandite proper, and $R Al_2 Si_6 O_{16} + 5\frac{1}{2} Aq$. for epistilbite and brewsterite. The physical properties of all the substances mentioned are quite alike and their optical peculiarities are not different.——The *chloritoid* of a graywacke schist from the Champion Mine, Mich., is similar in many respects to masonite, according to Keller and Lane.[21] It is undoubtedly triclinic with *B* inclined 20° to the basal cleavage. Its pleochroism is *C* = yellow, *B* = blue, *A* = green. An analysis gave:

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	K_2O	Na_2O	H_2O	Total
24.29	.28	34.00	10.55	20.52	tr.	1.29	.59	.97	.35	6.75	=99.59

Its hardness is 6.5 and density = 3.552.——Streng[22] again attempts to solve the composition of *melanophlogite* and succeeds in showing that the sulphur in its material is not in the form of sulphate but is more prob-

[19]Bull. U. S. Geol. Survey, No. 78, p. 80.

[20]Neues Jahrb. f. Min., etc., 1892, i, p. 12.

[21]Amer. Jour. Sci., Dec., 1891, p. 499.

[22]Neues Jahrb. f. Min., etc., 1891, ii, p. 211.

ably present as SiS_2, combined in some way with SiO_2, in the proportion $SiS_2 + 40\ SiO_2$. G. Friedel,[23] on the other hand, insists upon regarding the sulphur as occurring in the form of sulphate.——The *sigterite* from Sigterö, Norway, described by Rammelsberg[24] a short time ago as a new mineral, is acknowledged by this savant and by Tenne to be a mixture of eleolite and albite.——A greenish-white fibrous *talc* from Madagascar[25] has the composition $SiO_2 = 62.3$; $FeO = 2.6$; $MgO = 29.4$; $H_2O = 5.1$.——On a specimen of *dioptase*[26] in calcite from Central Africa Jannetaz has recognized octahedra of silver. This is the first report of the existence of native silver in that quarter of the globe.——Crystals of *barite* from Smithton and Sedalia, Pittis Co., Mo., consist of colorless portions enclosing yellow or white bands, in the latter of which Luedeking[27] and Wheeler find a large quantity of strontium and a small amount of ammonium sulphate. The composition of the crystals is $Ba\ SO_4 = 87.2$; $Sr_2SO_4 = 10.9$; $Ca\ SO_4 = .2$; $NH_4So_4 = .2$; $H_2O = 2.4$.——In consideration of the importance given by Tschermak to *meionite* in his discussion of the scapolite group Kenngott recalculates the formula of the mineral from new analyses recently published and derives $Ca_7\ Al_{10}\ O_{22}\ Si_{11}\ O_{22}$. He evidently places but little confidence in the Tschermak theory.——By mingling solutions of chromates, tungstates, molybdates, sulphates and selenates and studying the mixed crystals resulting Retgers[28] has shown that their alkaline and other salts are isomorphous, and that consequently when they are found as minerals they should all be placed in one group, which is trimorphous. The tellurates, on the other hand, are not isomorphous with any of the above mentioned compounds.——The walls of cavities of the leucite basalt from the south side of Lake Laach are covered with brilliant little crystals that have been carefully examined by Busz.[29] They are *hematites* on which are implanted *rutile* crystals and little colorless *olivines* with a tabular habit parallel to $\infty P \bar{\infty}$. All are supposed to be products of sublimation.——A. Schmidt[30] records the results of observations on pebbles of *zircon*, *almandine* and epidote from Adelaide, Australia. The zircon has a

[23]Bull. Soc. Fr. d. Min., xiv, p. 74.

[24]AMERICAN NATURALIST, 1890, p. 1189.

[25]Jannetaz, Bull. Soc. Fr. d. Min., xiv, p. 66.

[26]Ib., xiv, p. 67.

[27]Amer. Jour. Sci., Dec., 1891, p. 495.

[28]Neues Jahrb. f. Min., etc., 1892, i, p. 56.

[29]Zeits. f. Kryst., 1891, xix, p. 24.

[30]Ib., 1891, xix, p. 56.

density of 4.695 and a composition of $ZrO = 67.31$; $SiO_2 = 33.42$. The author also describes cubical and octahedral crystals of pyrite from Porkura, Hungary.——*Enargite* from Cerro Blanco, Atacama, Chile, has a density of 4.51. It contains $S = 32.21$; $As = 18.16$; $Cu = 47.96$; $Fe = 1.22$; $Zn = .57$.——The *amber-like* substance[31] occurring in the sands of Cedar Lake, near the mouth of the Saskatchewan River, in Canada, has been found by Harrington[32] to have the following composition: $C = 79.96$; $H = 10.46$; $O = 9.49$; $As = .09$. Its hardness is 2.5 and density 1.055. From its reaction with solvents the author concludes it to be *retinite*.——Lacroix and Baret[33] find *bertrandite* at Mercerie in the Commune of La-Chapelle-sur-Erdre, France. It occurs in crystals elongated parallel to the base, associated with orthoclase, albite, quartz and apatite, in a granitite.

[31]Neufville, Ib., 1891, p. 75.

[32]Amer. Jour. Sci., Oct., 1891, p. 332.

[33]Bull. Soc. Franç. d. Min., xiv, p. 189.

BOTANY.

Yucca Pollination.—Probably the most interesting case of insect pollination known is that of *Yucca* by the little moth *Pronuba*. Under the title, "Yucca Moth and Yucca Pollination,"[1] Dr. C. V. Riley has lately summarized the results of observations and investigations on this interesting subject. Having myself verified many of the observations detailed, I have consented, at Dr. Bessey's request, to outline the process of pollination as at present understood, for the NATURALIST.

Dr. Geo. Englemann[2] was evidently the first observer to notice the Yucca moth and suspect its relation to the pollination of *Yucca*. Specimens of the moth were sent to Dr. Riley who christened it *Pronuba yuccasella*[3], and took up the investigation of the subject obtaining surprising results. The subject has since been much studied but to Drs. Riley and Trelease we are chiefly indebted for its development.

Self fertilization in *Yucca* is practically impossible. The stamens curve away from the pistil, in several cases very strongly, thus placing the pollen at some distance from the pistil. The pollen furthermore is glutinous and not easily detached and blown about; and the three lobes of the stigma are erect and so arranged that pollen dropping cannot fall into the stigmatic tube into which, it is further found, the pollen must be inserted some distance to be effective. Thus *Yucca* is entirely dependent on outside aid for pollination. Few species of plants, if any, depend upon one species of insect for pollination. Many have very numerous pollinators. Yuccas, however, appear to be actually dependent upon some one species of the little moth *Pronuba*. All species of *Yucca* east of the Rocky Mountains are apparently dependent upon *Pronuba yuccasella*.

[1]Third Annual Report Missouri Botanical Garden, 1892, pp. 99–158, 10 plates.—The reader is referred to this article for all details. The life history of *Pronuba* and *Prodoxus* (the bogus Yucca moth) is discussed, and descriptions of all known species are appended. Several species are described as new.

[2]"The Flower of Yucca and its Fertilization," Bull. Torr. Bot. Club, vol. iii, no. 7 (July, 1872), and "Notes on the Genus Yucca," Trans. Acad. Sci. of St. Louis, vol. iii, No. 1 (April, 1873).

[3]"On a new Genus in the Lepidopterous Family Tineidæ, with Remarks on the Fertilization of Yucca," Trans. Acad. Sci. of St. Louis, vol. iii, No. 1, p. 55 (April, 1873).

Pronuba is not attracted to the flower by nectar. As Trelease has shown,[4] large nectaries are present in Yucca, but frequently little nectar is produced. It is questionable whether that produced is ever utilized by *Pronuba* as she has never been observed to feed. This, as Riley observes, "adds to the importance of *Pronuba* by showing that the acts of collecting pollen and transferring it to the stigma do not result in food compensation." The eggs of *Pronuba* are deposited in the young Yucca capsule at this time and fertilization is necessary in order that the larvæ which feed on the maturing seeds may develop. Thus *Pronuba* insures the development of the seeds by pollinating the plant and is compensated by having her larvæ provided for, so far as food is concerned.

During the day the moth may be found in the flowers where they remain, their white color, being the same as the flower, protecting them. In early evening they begin their work. The males are stronger of wing and flit back and forth among the flowers. The female has a work to perform and she loses no time in frolic. Hers is the work of ovipositing and Yucca pollinating. It is surprising with what deftness, accuracy and understanding she proceeds about her task. She first begins by collecting a load of pollen, a stage difficult to observe but now authenticated by many observers. She may be seen quickly running to the top of the stamen, where she pauses, and bending her head down over the anther, with her tongue and maxillary palpi (wonderfully modified for this purpose) extended on the opposite side of the anther, she scrapes the pollen from the anther sacs, and with the aid of her front legs, shapes the gathered pollen into a little ball. She proceeds from anther to anther till a relatively large load is collected, often thrice as large as her head. With this, Riley observes, she flies to another flower usually before ovipositing. I have never observed the gathering of pollen but I have frequently seen the same moth pass from flower to flower and from plant to plant, ovipositing and pollinating in many ovaries without stopping to collect more pollen. In this way cross pollination, in most cases, must surely result.

Equipped with her load of pollen, *Pronuba* proceeds to the further work of oviposition. She enters a flower and may be seen frequently for several minutes resting with the head toward the base of the flower, feeling around with the tentacles or slowly crawling around. Suddenly she awakens and with surprising activity runs rapidly around in the flower over the stamens and finally, in a few seconds, takes position

[4] "The Nectary of Yucca," Bull. Torr. Bot. Club, vol. xiii (August, 1886), p. 135.

for ovipositing, with the head usually toward the stigma backing down a little, with the body between two of the stamens, her legs straddling them. When a favorable point is found, which is generally slightly below the middle of the ovary, she rests for a short time, then raising the body slightly, thrusts the lance-like ovipositor into the soft tissue of the young ovary, penetrating into an ovarian cavity, where it is retained for a short time while the egg is being deposited. The ovipositor and oviduct are beautifully modified for this purpose. Oviposition only takes place in newly opened flowers, the first or second night after opening, the ovary usually being susceptible to fertilization only during these nights. The moth seems instinctively aware of this and never oviposits in an old flower. She evidently in running about the flower before oviposition, as explained above, seeks and learns whether the flower is in a receptive stage and whether it has been already punctured.

No sooner is oviposition completed than the moth proceeds to the act of pollination. She runs to the top of the pistil and bending over the stigma, works her head rapidly up and down, forcibly thrusting the pollen down into the stigmatic tube. The act of oviposition is usually followed by the act of pollination. This occurs so regularly and promptly that, as Trelease expresses it, " the moth seems to have it on her mind to perform the latter as a sequel to the former." When more than one egg is deposited in the same pistil it is thus pollinated more than once, and in some cases where as many as a dozen or more eggs are deposited in the same pistil pollination must be very profuse. There is a necessity for an abundance of pollen, however, as each of the three cells of the ovary contains hundreds of ovules. When the load of pollen is exhausted the moth has been observed to replenish her supply.

The larva of *Pronuba* in its development uses up only from 10–12 seeds, so even in those capsules where the most abundant larvæ develop, hundreds of good seeds are nevertheless produced. The few seeds destroyed may well be sacrificed to insure the pollination and development of the others.

About the time the pod begins to harden the full-grown larva bores its way out, makes its way to the ground, where after boring several inches below the surface it forms its silken cocoon. The larva transforms to the imago state a few days before the flowering of the Yuccas, and makes its way to the surface, where the moth escapes.

The interdependence of Yucca and *Pronuba* is thus seen to be very marked. It is a mutual relationship closely approaching that of sym-

biosis. The beauty and perfectness of adaptation is, however, yet more marked than I have outlined. Prof. Riley observes that Yuccas are very irregular in flowering, that a plant which flowers this year may not next year. This irregularity might prove fatal to *Pronuba*, but a beautiful device is found to meet it. Yucca moths are equally irregular, a large percentage of the moths failing to issue the year following oviposition, but are retarded until the second, third or fourth years after oviposition.

What is the meaning of the phenomena here observed? We are dealing, it is seen, with a case of pollination widely different from other known cases. In the most highly specialized protandrous flowers as in *Impatiens*, pollination by an insect or humming bird is entirely accidental. In the protogynous flowers of *Aristolochia* and *Arum*, so much admired for their beautiful device for securing cross pollination, carrying the pollen is an entirely unintentional action on the part of the gnats and flies, they going merely where they are allured. In the most perfect device of the many beautiful ones in orchids, the pollinia merely accidentally adhere to the insect and are carried from flower to flower as he flies about in search of nectar. Indeed, of all the beautiful and ingenious devices by which cross pollination is accomplished by animate beings, so far as known, *Yucca is the only case where this apparently intelligent pollination occurs. In all other cases it is accidental.*

Similar cases of apparently intelligent action among insects frequently occur, where food is provided beforehand for the larvæ. Such illustrations are the collecting of honey, the storing up of insects and spiders which have been killed for the purpose, or the laying of eggs in a branch or fruit stem which is afterwards girdled to provide dried material for the larval development. Between all of these devices, however, and Yucca pollination, there is, it appears to me, a wide difference. Such devices are the *inherited resultants* of easily understood facts or laws. The difference is merely a difference of degree truly. Such a difference as exists between the trained botanist and the rude understanding of the native American. The latter would understand that a girdled limb would in all probability die. Such things even his dull intellect will notice, as illustrations occur every day before his eyes. He could hardly be made to understand, however, that there is such a thing as sex in plants, although illustrations demonstrating this occur just as commonly under his eye. The nature of the problem is different. I do not credit the Yucca moth with a full understanding of what she is doing but it does seem that

either she or her ancestors must have had some idea of what was being accomplished. The point here seized upon and utilized in the development by natural selection is so different from those usually utilized. The points usually developed into permanent habits by natural selection and inheritance are, commonly occurring, easily understood laws. I, however, surely believe with Riley and others that this perfect adaptation of Yucca and *Pronuba* must be the result of natural selection, the gradual modification of some archetypal form.

However this development took place, one watching *Pronuba's* actions at the present time, so full of purpose and understanding, can hardly fail to conclude with Riley that it is not "blind instinct" alone that guides her.—H. J. Webber, *Shaw School of Botany.*

ZOOLOGY.

Trematodes.—All authors agree that Trematodes are provided with a superficial cuticle which is pierced by numerous minute canals, but their statements in regard to the origin of this cuticle are very contradictory. Thus Ziegler looks upon the cuticle as a metamorphosed epithelium, Schneider and Minot consider it the basal membrane of an epithelium which has been lost in the parasitic life of the worm, while Leuckart describes it as a product of the subcuticula. To these three theories Dr. Brandes, of Halle, now adds a fourth[1] of which the following is a brief resumé:

Trematodes do not possess any subcuticula in the true sense of the word; the subcuticula described by Leuckart and others is parenchymatic tissue which, together with a similar tissue found between the muscles, Brandes names ectoparenchym, to distinguish it from the endoparenchym, *i. e.*, the parenchym in which the genital organs are imbedded; *there is, however, a true cuticle present, which is a product of the subcuticular glands;* the cuticle is not pierced by canals.—C. W. Stiles.

Fishes of Ohio.—Oberlin College has begun the publication of a "Laboratory Bulletin." The second number, which has just appeared, contains a "Descriptive list of the fishes of Lorain county, Ohio," by the museum assistant, Lewis M. McCormick. In all 89 species are enumerated, and *Etheostoma wrighti* is described as new.

[1]G. Brandes, Zum feineren Bau der Trematoden, Zeitschrift f. w. Zool., 1892, Bd. liii, 4.

The paper is illustrated with 18 figures reproduced from the publications of the U. S. Fish Commission.

Necturus maculatus in the Hudson River.—In Prof. Cope's Monograph of North American Batrachia (United States National Museum Bulletin No. 34) an interesting feature of the geographical distribution of the Mud Puppy—*Necturus maculatus* Raf.—has been overlooked, viz., the fact that through the agency of canals the species has been introduced into the Hudson River and has become abundant both in the river and in its various tributaries.

Prof. Cope gives the habitat of the species as follows: "Ranges throughout the tributaries of the great lakes and the Mississippi, as well as the rivers that flow into the Gulf of Mexico and the Atlantic Ocean as far north as the Tar River, North Carolina."

Only one New York locality is cited, Grass River, St. Lawrence county. This is a tributary of the St. Lawrence River, and its source is not very far distant from the source of the Hudson. The only other locality cited which is at all near the Hudson is Burlington, Vermont. This locality also is in the drainage area of the St. Lawrence. Both the localities cited are covered by the statement "ranges throughout the tributaries of the great lakes," but there is nothing to indicate that the species inhabits the Hudson and tributaries.

De Kay, in 1842 (Natural History of the State of New York), predicted that the species would some day be found inhabiting the Hudson. De Kay's exact words on the distribution of the Mud Puppy in the State of New York were as follows: "This curious and interesting aquatic animal is common in the northern and western parts of the State. It is found in Lake Champlain, and is particularly abundant at the Falls of the Onion River and at the outlet of Lake George. It inhabits Lakes Erie, Seneca, and the other lakes in the western districts of New York. It has been found in the Erie canal, and will doubtless, ere long, be found to have reached the Hudson River." De Kay's prediction has come to be a fact. Whether the species came from the west through the Erie canal or from Lake Champlain through the Champlain canal, it is now so abundant in the neighborhood of Albany as to be somewhat of a nuisance. The city reservoirs are plentifully stocked with the species. A short time ago an individual was washed out of one of the fire-plugs in the heart of the city, and report says that another became wedged in the water pipes of one of our school-houses and had to be cut out in order to allow the water to flow.

As the Hudson and Delaware Rivers are connected by a canal which runs from Kingston on the Hudson to Port Jervis on the Delaware it is not improbable that the Mud Puppy will at some future time be found in the Delaware. At present no record of its occurrence in the Delaware is known to me, and probably it has never yet been found in that river. At least no mention of the species is made in Dr. C. C. Abbot's Catalogue of the Vertebrates of New Jersey, published in 1868, nor in Julius Nelson's revision of the same catalogue, published in 1890.

The presence of the species in the Hudson and its tributaries is worthy of note, as it is one of the very few instances in which we have apparently good evidence that the habitat of an aquatic animal has been unintentionally enlarged through human agency.

Wm. B. Marshall, *Albany, N. Y.*

The Foot in the Amniota.—It is well-known that the Dorking fowl is the only living bird which, in the adult condition, possesses a five-toed foot. Messrs. G. B. Howes and J. P. Hill have recently studied this form and they conclude[2] that the two inner toes are the result of fission of the hallux and that the variation in number of phalanges in the supernumerary toe is caused by degree of longitudinal subdivision. The hallux metatarsal is proximally prolonged into a rod of bone running parallel with the other metatarsal and articulating upon the inner condyle of the tibio-tarsus, a reversional characteristic unknown in other living birds, through which Archæopteryx had already passed and for which we must go back to the last aberrant tetradactyle Dinosaurs. In the general portion of this paper they show that this extra toe is not to be interpreted as a reversional reappearance of a usually missing hallux but rather as a splitting of the hallux normally present. Going farther they point out that the phalangeal characters of the different classes of air-breathing vertebrates throw light upon the phylogeny. In all mammals[3] the phalangeal formula is 2, 3, 3, 3, 3, or less; that of the Sauropsida 2, 3, 4, 5, 4, or less by reduction, while that of the Amphibia is 2, 2, 3, 4, 3, or less. In no known Amphibian, living or extinct, has the second digit more than two phalanges, and hence neither the sauropsidan or the mammalian foot can be derived from that of the Amphibia except by a process of intercalation of which we have no other evidence. This in

[2]Jour. Anat. and Phys., xxvi, 395, 1892.

[3]Except Cetacea, where Kükenthal argues that the supernumerary phalanges are dismembered and duplicated epiphyses.

connection with Cope's discovery of the mammalian condition of the limbs in the Theramorpha is strong evidence against the derivation of the Mammalia from the Batrachia; both Mammals and Sauropsida must have come from an ancestor with the phalangeal formula 2, 3, 4, 5, 4, or more.

Twisting of the Umbilical Cord.—In man and many mammals the umbilical cord is twisted but the twisting may be either right or left handed and the number of turns may vary. To explain this twisting several hypotheses have been advanced, the last being that of Prof. F. J. Allen.[4] The twisting consists in the twining of the two arteries about the single vein of the cord, and this involves an increase in length of the arteries greater than that of the vein. To test this Allen devised a model of rubber tubes and cord and found that the hypothesis was fully supported by the model. It is not easy to see what is the gain to either fœtus or mother by this twisting.

General Notes—Lower Invertebrates.—Dr. R. von Lendenfeld publishes[5] a preliminary arrangement of the calcareous sponges. The work is based upon the labors of Haeckel and Poléjaeff. Twenty-one genera are recognized.

Arthropoda.—Emile Deschamps claims[6] that the recently established genus Abacola of Prof. C. L. Edwards is synonymous with Thyopsyllus of Brady.

Dr. Paul Marshal describes a hermit crab (*Pagurus striatus*) which he found inhabiting a left-handed shell of *Neptunea contraria*. The abdomen of the individual was normal and showed the same lack of symmetry as its fellows, and on trial was found to hold itself equally well in both dextral and sinistral shells.

E. A. Birge publishes[7] a list of 64 species of Cladoceran Crustacea from Madison, Wisc. *Latonopsis occidentalis* and *Alona lepida* are described as new. A new species of Moina is indicated but not described.

Vertebrates.—C. K. Averill catalogues for the Bridgeport Scientific Society 246 species of birds found in the vicinity of Bridgeport, Conn.

[4]Jour. Anat. and Phys., xxvi, 300, 1892.

[5]Stz. Akad. Wien., Bd. c. Abth. 1, p. 4, 1891.

[6]Bull. Soc. Zool. France, xvii, p. 68, 1892.

[7]Trans. Wisc. Acad. Sci., viii, 1892.

EMBRYOLOGY.[1]

Spina Bifida and the Blastopore.[2]—Prof. Oscar Hertwig has made an important contribution to teratology and attempted the solution of some fundamental morphological problems in a paper that is disappointing from many points of view, though undoubtedly of considerable value.

In order to produce polyspermy in the frog, eggs were kept two to four days in a moist chamber before artificial fertilization was attempted, or else the female frogs were isolated for four to six weeks. In either case very many eggs developed normally, yet it is assumed that the hundred monstrous forms picked out were the results of some injury made upon the egg by the above treatment and that polyspermy took place.

This latter assumption is in no wise supported by any direct observations, but rests merely upon the previous work done by the author and others upon other eggs.

Passing over some interesting cases of irregular and of partial cleavage we will briefly describe the three sorts of monstrosities assumed to be imperfect conditions of gastrula stages.

In the first case there is a large yolk plug appearing at the surface of the embryo all along the dorsal, median region, so that such a monstrous embryo of five to seven days looks as if there were a huge blastopore with a medullary fold along each side of it and a plug of yolk cells projecting between these folds. At each end of this plug a depression leads ventrally, a sort of fore gut and hind gut. At the posterior end two elevations represent a sort of double tail. In fact, the medullary groove or tube and the notochord are *double* and pass along each side of the yolk plug.

In a second set of abnormalities the embryos have advanced so far as to have eyes, external gill slits, a short tail and a heart. The tail is bent up at right angles to the trunk and anterior to it is a small plug of yolk coming to the surface on the median dorsal line. Internally the nerve tube and the notochord are double on each side of the yolk plug, or open blastopore, but anterior to that form normal, single structures. Posteriorly they run as paired organs into the tail, which

[1]Edited by Dr. E. A. Andrews.

[2]Archiv f. mikros. Anat., xxxix, 1892, pp. 353–492, plates 16–20.

usually appears a single structure externally but may be quite deeply bifid or double from the base. Posterior to the tail a median groove may run in to the digestive tract as an anal pit.

The third class of monstrosities presents only a slight departure from the normal, having a prominent yolk plug not closed in when the larva is even older than in the second class. This plug occupies the position of the normal blastopore or anus of Rusconi, posterior or ventral to the tail, and is due to a failure of the ventral lip of the blastopore to grow up as soon as it should have done.

In interpreting these peculiar abnormal embryos the author assumes that they are all cases of arrested development, that the yolk plug is in each case really the blastopore, which has failed to close at the proper time, thus causing the median dorsal parts of the embryo to appear as paired structures along the lateral lips of the huge, open blastopore, whereas, they normally would first appear as single structures along the median dorsal line when the blastopore had closed there. The retardation in the closure of this dorsal blastopore has thus kept dorsal structures separated till they have so far developed as to form half structures widely apart; later, when the blastopore closes, these halves may grow together more or less perfectly and so produce a normal form.

It is to be regretted that individual cases were not actually watched so that there might be no doubt concerning the real value of these great, dorsal, hernia-like yolk plugs.

The author thus definitely adopts the position, hitherto held only by Roux and opposed by Schultze, that the frog larva develops along what was the light-colored side of the egg, the blastopore closing in successively from the head towards the tail along this aspect of the egg. He regards the blastopore in the frog as a median, dorsal opening extending the whole length of the trunk, normally closing in till the anus of Rusconi and the definitive anus are left as evidences of its posterior portion, while anteriorly a median "rückenrinne" and the lateral origin of mesoblast and the relations of the notochord give evidence of its existence through the whole length of the animal.

Increase in length would not take place anterior to the closing blastopore so much as at the actual point of successive closing, the blastopore advancing posteriorly *pari pasu* with its gradual closing.

Hertwig takes a definite stand as a supporter of the concrescence theory of His, modifying it somewhat when extending it to all vertebrates by regarding the neurenteric canal as also a part of this dorsal blastopore.

In discussing the blastopore and concrescence in various vertebrates a sharp distinction is drawn between the true blastopore or depression leading into the digestive tract and the growing edge of the blastoderm, "Umwachsungsrand" as it may be called. Only part of the latter may, in some cases, become the blastopore. Thus in the bony fish the blastopore consists of a short transverse portion or sickle and a longitudinal constantly elongating and closing median groove running forward from the sickle. The sickle is gradually formed more and more from the edges of the blastoderm, the "Umwachsungsrand," till the latter is eventually used up in this way, becoming converted into sickle-groove, which in turn is gradually closed in along the median, dorsal line of the embryo. In the shark, however, the "Umwachungsrand" soon leaves the sickle and the partly closed in portion of the blastopore and then closes by itself; is not then part of the blastopore. In the chick or in a reptile this separation is such an early one that the true blastopore is quite removed from the edge of the circular growing edge of the blastoderm, which then is not to be reckoned as part of the blastopore at all.

The anus of vertebrates is regarded as the posterior part of this elongated blastopore, hence the vertebrate tail is morphologically, as in some of these monstrous frog embryos, a double structure growing out from the right and left lips of the blastopore. The tail, with its neural tube, notochord, mesoblastic somites and portion of the entoblast is then not a prolongation of the trunk, but a dorsal outgrowth of different value. It elongates by a transfer of the "Wachsthumszone" to its tips and in the same manner as the trunk elongated. How it is possible for the closing in process and growth to take place posterior to the tail and also at the tips of the tail the author does not explain.

Having brought forward some arguments for his coelom theory and replied to certain criticisms of Götte the author next discusses at length the relation of the blastopore to various abnormal forms in vertebrates. He takes the view that the formation of several embryos from a single egg is to be referred back to the formation of as many gastrula invaginations in that egg. The difference between such multiple monsters in different groups of vertebrates is then due to the differences in the gastrulation, to the various possible ways in which multiple invaginations may arise in different sorts of eggs. The apparent absence or great rarity of double monsters in the Amphibia may be due either to the small size of the egg and difficulty of double invagination or it may be that such doubleness is early obliterated by following fusion

into normal structures. In the bony fish the tendency to the formation of double-headed monsters would be due to the method of closure of the blastopore, two invaginations being easily brought together to form a common trunk. In the chick, however, this cannot so readily take place, but embryos arising peripherally on the blastoderm tend to have their heads fused while the tail ends are not brought together by the fusion of any growing edge forming the blastopore and so remain separate.

This leads to the consideration of the conditions producing double germs from a single egg. A single egg after the first cleavage has the power to produce two individuals of normal structure but half the normal size. This is the necessary result of the process of cell division as previously explained by the author, and has recently been shown experimentally by Driesch, Chabry and not really negatived by Roux, when his work is interpreted as seems just.

The first two cells of a cleaving oosperm develop into right and left halves only because of their association together; separated each would form a perfect organism.

The reason for the manifestation of this double power in double monsters is to be sought in the action of forces before cleavage. Of these the author regards polyspermy as the most efficient. This view the author upholds in spite of the many negative experiments that have been made upon echinoderm eggs (and upon frog eggs in the present paper, granting that polyspermy actually took place in the frog's eggs used).

Here it may be noted that the author assumes throughout that the frog's eggs were injured by the treatment he gave them, and that more than one sperm entered each abnormal one.

There is, however, no evidence of this in the present paper; we find only a certain similarity between the treatmont of the eggs and the treatment of echinoderm eggs when polyspermy actually ensued.

Back of the effects produced by entrance of many sperms there is the abnormal state of the egg allowing of this multiple fertilization.

This state of the egg with the effects of polyspermy remain latent until later several invaginations may result and from these eventually double monsters are formed if there be not a complete fusion of the first rudiments.

The connection between polyspermy and the formation of double monsters is thus by no means a direct nor a simple one, yet of the many factors concerned the effects of polyspermy are, in the author's estimation, the important ones.

ENTOMOLOGY.

Harvest Spider Notes.—A recent study of a large number of specimens of the common striped harvest-spider, from all portions of the United States, leads to the conclusion that the northern and southern forms so intergrade that they should rank as a single very variable species, instead of being considered two species as now recognized. The southern form having appeared in the original publication before the northern, has precedence, and should as now be called *Liobunum vittatum* (Say) while the northern form is *Liobunum vittatum dorsatum* (Say). An illustrated paper giving a more complete account of the species will appear in the NATURALIST at an early date.

During the spring just passed I collected a number of the harvest-spiders described by Dr. Wood as *Phalangium formosum*, and since placed by myself in the genus *Forbesium*. They were confined in vivaria and fed on plant-lice; but instead of depositing eggs as I had hoped they would, they continued growing and casting their skins until they evolved themselves into another genus and species—*Liobunum ventricosum* (Wood). This fact accounts for their sudden disappearance each spring. It is not unlikely that the specimens referred to *formosum* may include, in other localities, the young of other species. If the southern *Forbesium hyemale* proves to be also the immature form of another species, the genus will become a synonym.—CLARENCE M. WEED.

Protective Resemblance in Trombidium.—While collecting the past spring I have frequently stooped to pick up what I supposed to be the common New England red mite (apparently Say's *Trombidium sericeum*) only to find one of the seed-capsules of one of our abundant Sumachs, which in the spring are widely scattered over the ground. A few feet away the resemblance between the Trombidium and these detached capsules is very striking, the color often being precisely alike. If the mites are at all subject to attack by birds this resemblance must enable many to escape.—C. M. W.

The South Dakota Insectary.—The experiment stations are gradually perfecting their facilities for the study of injurious insects, several of them already having insectaries for carrying on observations

and experiments. A recent bulletin from South Dakota gives the following account of the new insectary at Brookings:

Recognizing the necessity of facilities for rearing insects in a situation where all external conditions could be controlled, as well as of a suitable place for keeping the collections and apparatus of the department, the board of trustees last year authorized the construction of a building for the entomological department. This was occupied about June 25. It is a structure 16x32 feet in size, with wing 12 feet square. In the main part is the general office and work room, 16 feet square, a well finished room, provided with desk, tables, balances, shelves for collections, &c. Here are kept a general collection of all orders of insects, chiefly collected in this locality; some economic collections, showing the transformations, work and parasites of some of the common injurious insects; samples of various insecticides, and a few bee supplies.

The rearing-room, or insectary proper, occupies the remainder of the main part of the building. It is an unfinished room with dirt floor, lighted by five large windows. It is as yet but partially fitted up, owing to the fact that the rearing season was almost past when we moved into the building last spring. Breeding cages and other devices for this line of work will be in operation this year.

The wing on the east side of the main building is devoted to bee-keeping and storage of machinery, &c. The bees are placed on a low shelf along the side of the room, the faces of the hives toward the outside. Horizontal slits through the wall, one immediately in front of each hive, give the bees egress. This arrangement is called a house apiary, and presents several advantages in our circumstances. The hives are safe from violent winds and are in a very convenient place for working with them, as by nearly closing the door the room can be darkened until the bees will not fly in it.

Wasps and Humming Birds.—My attention was recently called by Prof. H. G. Jesup to a row of English white birch trees in Hanover, N. H., which had been bored by woodpeckers. Although most of the holes were old, the sap was evidently still exuding about some of the trees as they were visited by swarms of flies, and many wasps, particularly the "white faced hornet" (*Vespa maculata*). There were also several humming birds (*Trochilus colubris*) eager for a taste of the sap. But whenever one of the latter approached a wasp would dash savagely at it and drive it away. This was repeated over

and over again on different days, and it only rarely happened that the birds were rewarded by a short suck of the coveted liquid.—C. M. W.

Recent Publications.—Bulletin No. 27 of the U. S. Division of Entomology consists of reports on the damage by destructive locusts during 1891 in California, Colorado, Kansas and other Western States. The reports were prepared by Messrs. Bruner, Coquillet, and Osborn, field agents of the Division.

The April, 1892, Bulletin of the Ohio Experiment Station consists of a discussion by Mr. F. M. Webster, of the "Insects which burrow in the stem of wheat." Seven species are included. * * * Mr. Lawrence Bruner's report as entomologist to Nebraska Board of Agriculture for 1891 consists of a short, illustrated treatise on corn insects. * * * Dr. J. B. Smith's report for 1891 as entomologist of the New Jersey Experiment Station contains several excellent practical discussions of injurious insects, with many good illustrations. * * * The March Bulletin of the South Dakota Station, and the May Bulletin of the Iowa Station contain valuable entomological articles. Baron C. R. Osten-Sacken[1] has a paper of additions and corrections to Dr. S. Wendell Williston's catalogue of the Asilidæ of South America published last year. The shrimp, *Palæmon ornatus*, has recently and suddenly appeared in great numbers in the Hunter River of Australia.

[1]Berliner Entomolog. Zeitshrift for 1891, xxxvi, 417, 1892.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Cornell Medical Society.—May 24, 1892.—Prof. B. G. Wilder read a paper upon the "Appendix of the Cæcum. Its Origin and Destiny." After showing how this dangerous organ is developed in the individual the speaker took up the subject of its development in the animal series, and showed that while it might possibly be present in the wombat it is certainly present in the lemurs, but not in the ordinary monkeys. When, however, we come to the true apes (gibbons, chimpanzees, orangs and gorillas) there is found an appendix far more dangerous than in man even. Dr. Wilder suspects that the presence of this dangerous appendix in the apes may be an important element in holding them back and enabling man with a less dangerous one to outstrip them in the race of life. No doubt the appendix is a rudiment or remnant of what in our remote ancestors was a useful organ. It is being slowly eliminated. In view of the fact, however, that so great a number of persons suffer or die from disease of the appendix (it is reported that at least one person is operated on daily for it in New York), and from the fact that it seems now to have no function except to act as a death-trap, Prof. Wilder renews the suggestion made several years ago that as we vaccinate to avoid small-pox, so it might be advisable to remove this objectionable and useless organ from children and thus give them a better chance to survive. It might be hoped also that as in the struggle for life nature seems to take advantage of useful variations, she would take the hint and leave off this unwelcome organ altogether.

Many specimens were shown illustrating the points brought out. One of great personal interest was the appendix lately removed from one of the Cornell professors, the removal of which, no doubt, saved his life. The professor was present and added greatly to the interest by a discussion of the subject from the standpoint of evolution and personal experience.

SCIENTIFIC NEWS.

First Tile Fish in Ten Years.—The United States Fish Commission schooner "Grampus" returned, Aug. 7, from an examination of the deep water fishing grounds south of Martha's Vineyard with a tile fish, the first which has been caught in 10 years. The mysterious disappearance of this fish in 1882 was the subject of considerable discussion and comment at the time, and its cause was variously accounted for. The fish was first discovered in 1879 by a Gloucester fishing schooner, which secured a large number of them. Specimens were sent to fish experts and the markets, and it was at once recognized as a fish of value for its food qualities.

As it was found within a few hours' sailing distance of New York, the fishermen saw that it gave promise of an important additional fishing ground. The fish commissioner, realizing the important nature of the discovery, began a careful investigation of the entire region in order to determine the extent of the grounds, the abundance of the fish and the best means of catching them. The investigation was pursued during the summers of 1880 and 1881, specimens being taken on nearly all the trips made by the commission vessels to this region. The result of these trips showed that the fish were abundant, and that the hopes based upon the discovery were well founded.

In the spring of 1882, however, enormous quantities of this fish were found dead upon the surface of the ocean, from Nantucket to Cape May, and since that time none of them have been taken, despite the efforts put forth at frequent intervals to find them.

In 1889 a systematic study of the relations of the gulf stream and the Labrador current was instituted by the commissioner, Col. M. McDonald, with the idea of establishing a connection between the changes in the temperature of the water and the movements of the schools of fish. During the course of the investigation for the past three years it was found that a deep warm water band was approaching the edge of the continental platform nearer and nearer each year. The idea suggested itself that if this band came in contact with the continental platform throughout its whole extent, the feeding grounds of the tile fish, which was a tropical fish, might be possibly so extended that it would find its way far to the northeast and up to the point where the land naturally left the end of the platform at the position where the fish was first discovered. If, then, this band should be with-

drawn, the first place at which it would leave the edge would be in the great bend of the coast opposite New York, and the water there would be too cold for the fish to live in. The consequence would be that those fish that had found their way farther east, as well as those upon their ground, would be subject to conditions which would bring about the result accomplished: namely, their wholesale destruction.

The "Grampus" went out to the above named region off Martha's Vineyard, and, finding by the temperature observations that this warm area has been very much increased, the trawl lines were set and the fish caught.

It is now the intention of the commissioner to follow up the success by mapping out the warm area to the southwest, setting trawls to determine the relative abundance of the fish, and to put the information in proper shape to be utilized by the fishermen.

—A NEW monthly journal devoted to natural science has appeared in England, and is published by MacMillan & Co. It is supported by several of the younger English scientists, and is ably conducted. It is a valuable addition to our current scientific literature, especially as it furnishes a full opportunity of discussion for naturalists of Neolamarkian proclivities, which has not been hitherto obtainable in the pages of the older journal, Nature. We observe a tendency to rather undiscriminating criticism in its editorial notes, but this is better than the suppression and mutilation of articles which has characterized its predecessor in the same field.

—THE Marine Biological Laboratory at Wood Holl has just completed its most successful season. It has had a corps of 17 officers, instructors and assistants, and an attendance of 38 investigators and 62 elementary students; or total of 117.

Among the recent promotions at the Johns Hopkins University are the following: Dr. E. A. Andrews, associate professor of biology; Dr. William B. Clark, associate professor of geology; George P. Dreyer, associate in biology; George H. F. Nuttall, associate in bacteriology and hygiene.

Recent appointments at Harvard University: William Henry Howell, associate professor of physiology; Henry Parker Quincy, instructor in histology; Franklin Dexter, demonstrator of histology; Henry Jackson, demonstrator of bacteriology; Daniel Denison Slade, lecturer on comparative osteology; William Francis Ganong, instruc-

tor in botany; Thaddeus William Harris, instructor in geology; Charles B. Davenport, instructor in zoology; William M. Woodworth, instructor in microscopical anatomy.

The University of Kansas has established a periodical under the name "The Kansas University Quarterly." The first number, dated July, 1892, contains the following papers: Kansas Pterodactyls, Part I, and Kansas Mosasaurs, Part I, by Prof. S. Wendell Williston; Notes and Descriptions of Syrphidæ, by W. A. Snow; Notes on Melitera dentata Grote, by V. L. Kellogg; Diptera Brasiliana, Part II, by Prof. Williston.

The Société Zoologique de France starts the year 1892 with 277 members.

Herman Burmeister, zoologist, died at Buenos Ayres May 1, 1892. He was born Jan. 15, 1807, at Stralsund, studied at Greifswald and Halle, and was elected to the chair of natural history at the latter university at the death of Nitsch. Owing to the troubles of 1849–50 he went to South America, and with the exception of two trips to Europe he spent the rest of his life there. In 1861 he became the director of the Museum of Buenos Ayres, and nine years later became the head of the faculty of sciences in the University of Cordoba. He is best known for his early work on entomology and his later papers describing the physical geography, zoology and paleontology of South America.

Chairmen of Committees on Anatomical and Biological Nomenclature.—CORRECTION.—In a circular, "American Reports Upon Anatomical Nomenclature," issued last winter by Prof. Wilder as Secretary of the Committee of the Association of American Anatomists, in the third paragraph of the third page, the Chairman of the Committee of the Anatomische Gesellschaft should be Prof. A. von Kölliker, and the Chairman of the American division (appointed in 1891 by the American Association for the Advancement of Science) of the International Committee on Biological Nomenclature should be Prof. G. L. Godale. Prof. Wilder desires to express his regret for the errors, due in the one case to his own misapprehension and in the other to a clerical mistake.

C. L. Herrick, formerly of the University of Cincinnati, and recently elected professor of biology in the University of Chicago,

has accepted a call to a chair of biology and neurological research in Denison University, Granville, Ohio; Prof. Wm. G. Tight retains his position in charge of geology and botany. Recent gifts of about $75,000 are to be largely devoted to the erection and equipment of a scientific building.

The Journal of Comparative Neurology will also be published from Granville under the patronage of Denison University.

ERRATA.

On page 637 in the August No. the date 1882 should read 1862. In the review Erlanger's work upon Paludina (same number) page 709, line 13 for "mouth" read "mantle;" page 712, line 4, for "chiton" read "Amphineura."

RECORD OF NORTH AMERICAN ZOOLOGY.

Continued from Vol. XXVI, p. 724.

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AMERICAN NATURALIST

Vol. XXVI. October, 1892. 310

THE PROBLEM OF MARINE BIOLOGY.

By George W. Field.

In common with the other branches of biological science, the study of marine life has made wonderful advances in the past half century, and we now begin to get a proper conception of the vastness and importance of this realm of nature.

The study of marine life has been compassed by serious difficulties; on shipboard it is impossible to examine in the living condition the enormous quantity and endless variety of forms brought up at a single haul of the net or dredge; and the old method of merely dropping the specimens into vials of alcohol resulted in vials of wrath to the naturalist who later studied the creatures in hopes of gaining from the distorted relics some knowledge of the normal appearance and anatomy. Now all this is changed, and by aid of certain chemical reagents most animals can be killed and preserved in a manner very satisfactory for study of their gross and microscopical anatomy, and hence the material collected can be examined at leisure in permanent laboratories with results corresponding to the better facilities. There has, too, been a great lack of suitable and accurate collecting apparatus. The early method was to scoop up a quantity of sea water and then tediously examine it in small quantities under the microscope. In 1845 Johannes Müller, the great pioneer of marine biology, conceived the idea of condensing into a small volume of water

the forms which would be found in a very great area. This resulted in the invention of the "Müller Net," a small gauze net which is drawn through the water, entangling in its meshes the very minute and delicate organisms. For a long time Müller and his students pursued the study of marine forms, and at length came the discovery that the marine fauna and flora was directly comparable to the terrestrial.

Yet little is known of the laws of the distribution of marine life. The laws of the distribution of the terrestrial fauna and flora have been formulated for animals in the classical works of Wallace and for plants by Griesbach. The famous "Challenger" expedition (1873–1876), under the direction of Sir Wyville Thompson and Dr. John Murray has given us the largest conception of the wealth of marine life, and has laid the foundations for the study of the marine forms both at the surface and in the depths of the ocean. Dr. Murray in his preliminary report called particular attention to the enormous wealth of organic life not only at the surface, but also many hundred fathoms below. He says that when living forms were scarce on the surface the tow net usually disclosed very numerous forms below, even to a depth of 1000 fathoms or more. In the North Pacific Ocean the discovery was made that zones of definite depth are characterized by animals and plants peculiar to them. The tow nets sunk to 500, 1000 or 2000 fathoms brought up forms never found within 100 fathoms of the surface. The animals characteristic of these different depths are, for the most part, of the class of Radiolorians, those microscopic organisms whose silicous skeletons form much of the soft ooze which carpets the bottom of the deep sea. Prof. Haeckel, by study of this material was led, in his monumental work on the Radiolaria, which forms a part of the "Report of the Challenger," to the recognition of three groups, (*a*) pelagic, swimming at the surface of the calm sea; (*b*) zonary, swimming in definite zones of depth (to a depth of more than 20,000 feet); (*c*) profound (or abyssal) animals swimming immediately over the bottom of the deep sea. In general the different characteristic forms correspond to the different zones (up to 27,000 feet).

The existence of this intermediate pelagic fauna was called in question by Alexander Agassiz, on the ground of the liability of error in using the ordinary open net instead of one which could be closed at a definite depth and then drawn up; and more particularly upon the ground of his own experiments made in 1878 on the "Blake" expedition. He believes that the great bulk of the ocean contains no organic life at all, that the surface fauna of the sea is limited to a relatively thin layer, and that there is no intermediate layer, so to speak, of animal life between the fauna of the bottom of the deep sea and of the surface.

Agassiz's results are contradicted by those of Chierchia on the Italian corvette "Vettor Pisani." With the closable net invented by Palumko he brought up an astonishing quantity and variety of forms of life from different depths, even up to 4000 meters. Prof. Carl Chun, with an improved closable net, studied the marine fauna and flora of the Gulf of Naples. He formulates his results as follows: 1. That part of the Mediterranean investigated shows a rich pelagic life even to a depth of 1400 meters, as well as at the surface. 2. Pelagic animals, which during the winter and spring appear at the surface, at the beginning of summer seek the depths. 3. At greater depths pelagic animals occur, which hitherto have seldom or not at all been observed at the surface. 4. A number of pelagic animals during the summer remain at the surface and never go into the depths. From his observations upon the vertical distribution of marine life he was led to remark that the surface fauna was apparently only the advance guard of the vast army below. His conclusions were confirmed by observations made during a trip to the Canary Islands, and agree with those made by Prof. Haeckel twenty years before.

Prof. Hensen, of Kiel, has for several years past been studying the phenomena of pelagic life with a view of ascertaining its relations to the fisheries question. He has proposed the term Plankton (from πλάνομαι, to wander) to designate this world of marine life. Prof. Haeckel agrees with this and adds Planktology, that branch of biology which deals with the study of the Plankton. Prof. Hensen hopes to gain val-

uable information upon the phenomena of marine life by a careful mathematical estimation of the number of individuals in a given bulk of water. Presumably from this and other data some knowledge may be gained of the quantity of life which any definite area of the sea is capable of sustaining.

Prof. Ernst Haeckel, of Jena, has lately published an admirable resumé of our knowledge of pelagic life, and has made a very distinct advance by formulating some of the laws which govern its distribution. He has probably done more than any one man to advance our knowledge on this line. Ever since 1854, when, as he tells us, he accompanied the great Johannes Müller to Heligoland and was there introduced by his master to the marine wonderland, he has almost continuously pursued the study of the Plankton. He believes that aquatic life in its broadest features shows conditions of distribution similar to those of terrestrial life, and that we may for the former as well as for the latter distinguish five great geographical provinces, each represented by characteristic forms of animals and plants. 1. The Arctic Ocean. 2. The Atlantic. 3. The Indian. 4. The Pacific. 5. The Antarctic.

All aquatic organic forms fall into two great divisions. 1. Those which live free in the water, either swimming actively or passively floating at the mercy of currents and winds. These compose the Plankton. The Plankton thus includes the widest range of organic size and form, from the minutest microscopic organisms to the gigantic cetaceans. 2. Those forms which live upon the sea bottom, either fixed or creeping about. To these the term Benthos (τό βένθος, the bottom of the ocean) is applied. The variety of forms living near the shore is known to vary with the depth, while the forms characteristic of the comparatively shallow waters of the coasts are widely different from those which inhabit the bottom of the deep sea.

The number and the kind of forms composing the Plankton are found to differ with the quality of the water, *i. e.* fresh or salt. In the ocean there is a marked difference which is conditioned by the distance from the shores, either of continents or islands. There are many species of animals, particu-

larly certain coelenterates, echinoderms and worms, which pass only part of their life as free swimming animals; for the remainder they are bottom dwellers. Such species are not usually found far from the coast, and hence the true oceanic Plankton is made up of forms which pass their entire life as free swimming organisms. By the presence or absence of these bottom dwelling species the Planktologist can determine approximately the region where the forms were captured.

A mere list of the genera, not to mention the species of plants and animals up to the present found to take part in the constitution of the Plankton would be very formidable. The range in size is enormous; from the exceedingly minute unicellular algae $\frac{1}{25000}$ of an inch in diameter to the huge bulk of many fishes and cetaceans. The microscopic forms constitute the fundamental food supply in the cycle of marine life. They are capable of exceedingly rapid multiplication, and furnish nourishment for the myriads of large animals, which in time are preyed upon by the still higher forms. The inconceivable number of individuals of the smaller species is demonstrated by Prof. Hensen's determination of the number of individuals in about two cubic yards of Baltic Sea water. This was found to contain 5,700,000 distinct organisms; of these only about 150,000 were visible to the unaided eye. But very often microscopic forms become so numerous as to form a slime upon the surface of the water for a considerable area. Ships frequently sail for miles through water colored by these microscopic organisms, *e. g.* the so-called "black water" of the Arctic and Antarctic Seas, is a slime of diatoms, which serve as food for the shoals of minute crustacea and mollusca (Pteropods, sea butterflies, and Cephalopods, squid, cuttlefish) upon which the walrus and whales feed. In the warm regions the inconceivably enormous quantity of diatoms are replaced by another kind of algæ, the Oscillatoriæ, which often for an area many miles in extent color the sea a dark red or yellowish brown. The Red Sea received its name from the abundance of one of these algæ, *Trichodesmium erythræum*, which, according to Ehrenberg, colored the water along the shore a blood red. In the warm region also are

found the huge floating banks of Sargassum, or gulfweed, forming the so-called Sargasso Seas of the Atlantic and Pacific Oceans. These areas are found to have a marine fauna and flora peculiar to themselves, but approximating in character to that of the coast waters.

The simplest forms of animal life of the Plankton belong to the groups of Infusoria and Rhizopods; to the latter belong those minute animals, the Foraminifera and Radiolarians, which occur in such enormous quantities that their calcareous and siliceous shells form the "deep sea ooze" which carpets the bottom of the deep sea. It is the shells of these animals too, which have built the vast chalk beds in various parts of the world. Among the multicellular animals which take a prominent part in this marine world are many species of medusæ (jelly fish) and the closely related Siphonophores, of which the beautiful Portuguese man-o'-war is the most familiar representative. The class of worms is represented by many free-swimming species; but in the number of individuals it is far surpassed by the molluscs, chiefly represented by the squids, the pearly and paper nautilus, and the huge cuttlefish, and by the minute and delicately beautiful sea butterflies (Pteropods), which occur in vast schools in the polar seas. Often too, in very considerable number are found the free-swimming larvæ of Echinoderms, as also many worm larvæ, which, like the former, pass their adult life upon the bottom. Every haul of the gauze net is certain to contain some representatives of the great class of Crustacea, often great numbers of species, as well as of individuals. In distribution these seem to be subject to pretty definite laws, and a careful study of the phenomena would be of great interest. There are found also certain Tunicates, a group interesting because many investigators believe that here we find the transition from the invertebrate ancestor to the higher plane of life of which man is at present the highest representative.

The vertebrates of the Plankton embrace the great group of fishes, and in addition the marine birds, the seals and walrus, and finally the cetaceans. In this connection, too, the enormous number of fish eggs floating at the surface of the ocean,

as well as the transparent, newly-hatched fry must be mentioned. Prof. Hensen hopes to get an idea of the approximate number of fish of a given species in a certain area, computing the number of eggs and fry of that species within that area.

The phenomenon of marine phosphorescence is very widely known with admiration and wonder. Its cause is chiefly or solely bound up with organic life. The majority of pelagic animals display the phosphorescent light in different degrees. In some the entire living animal is brighly luminous; in other the light is limited to special organs. But much of the phosphorescence of the ocean appears to be caused by the fragments of dead organisms, and is connected with the presence of bacteria.

Since many chlorophyll-bearing organisms are found at depths unpenetrated by sunlight it has been suggested that the light necessary for their growth is furnished by the phosphorescent organisms.

The composition of the Plankton is exceedingly irregular, both in qualitative and in quantitative relations; its distribution in the ocean is also very irregular, both in time and in place. The variations occur near the shore as well as far out at sea. Very often the greater part of the mass of Plankton is made up of organisms belonging to a single group. Sometimes unicellular algæ make up nearly the whole bulk, at another medusæ, siphonophores or ctenophores; indeed, almost any group of marine organisms may occur in such quantities as to compose more than one-half of the total bulk of the Plankton, at that time and place. The fundamental causes of variation in the quantity and quality of the Plankton appears to be conditioned by time, climate and currents.

Temporal Differences.—For a satisfactory determination of these more complete observations are needed. Reliable data can be furnished by the observations at the numerous marine laboratories and zoological stations now springing up in different parts of the world. The causes which underlie these yearly, monthly, daily and hourly variations are manifold; in part meteorological, in part biological. They are comparable

to the corresponding oscillations of the terrestrial fauna and flora, and depend on the one side upon climatic and meteorological conditions, and on the other upon the varying mode of life, particularly upon conditions of reproduction and development. Just as the annual development of most land plants is bound up with a definite time of year, as the time of budding and leafing, of blooming and fruiting, have in the "struggle for existence" become adapted to the meteorological conditions, the time of year and other conditions of existence, so too the annual development of most marine animals is conditioned by definite habits, which have become fixed by heredity. The yearly variations may be compared to the good and bad fruit years. This yearly variation has been noted by many observers in case of many marine animals. Our attention is often called to an example of it in the unusual abundance or scarcity of the catch of certain food fishes.

Many marine animals, particularly certain medusæ, siphonophores, ctenophores, molluscs and tunicates, are found at the surface only periodically, in one or a few months of the year. This is probably dependent upon conditions of reproduction and development, as well as upon the temperature of the season. The daily variations are conditioned by the weather and particularly by the wind and rain. A shower will very quickly reduce the specific gravity of the surface water and thus drive the surface dwelling animals below. Many animals rise to the surface only at a definite time of day, some in the morning, others at noon, and yet others only towards evening.

Climatic Difference.—Prof. Haeckel thinks that the quantity of the Plankton is very little dependent upon the climatic difference of the zones, but that the quality is greatly so, and indeed in this way, that the number of component species diminishes from the equator to the poles. These conditions, he believes, are directly referable to the influence of the sun, "the omnipotent creator," whose more direct rays bring about an acceleration in the processes which make up the cycle of life. As this is true of the terrestrial fauna and flora so it is true of the marine.

Currentic Differences. — Conspicuous differences are also brought about by the numberless currents, great and small, by the little-known deep sea oceanic currents as well as by the better-known great surface currents, the Gulf stream, the Falkland stream, the Guinea stream and others. These currents play a great rôle in the distribution of many forms of life. More local influences are exerted by the small currents whose causes are found in the climatic and geographical conditions of the adjacent coast. The relations of Plankton life to currents is little known, and needs investigation, but first a better knowledge of the currents themselves is necessary.

Almost everyone who has seen the surface of the ocean in a calm has noticed the glassy areas of irregular shape. These are found on the high seas as well as in sheltered bays and harbors, and are of very special interest to the student of marine life. So far as made out they are extremely irregular in time and place of appearance, and the conditions governing them have not been carefully studied. They are in a measure influenced by winds and currents, by the ebb and flow of the tide. Here, into a limited space, are crowded great numbers of organic forms; this space is readily distinguished from the surrounding water in which there is comparatively little life. These phenomena have been noticed by seafaring men and have many different names in different countries.

A word in conclusion as to the bearing and importance of the Plankton in human economy in the near future. When Malthus promulgated his famous doctrine he failed to consider the final element which enters into the problem of human population, the human mind. The ingenuity of the human mind has brought about a decreased efficiency in the natural checks to undue increase, and thus an artificial increase in the food supply is rendered necessary for the crowding population. This food supply is now mainly derived from the cultivation of the land. A still further increase of population will necessitate a levy upon marine life. As soon as man to any great degree becomes a factor in the Plankton conditions by drawing from it large quantities of food, particularly in the form of mature animals, the equilibrium of oceanic life

will be disturbed, and must be adjusted by artificial means. But further, a study of the phenomena of marine life shows that the water as well as the land, through cultivation, is capable of producing a greatly increased food supply for man. The necessity of cultivating the marine resources is even now apparent, and many governments have already begun to cope with the question by the establishment of commissions of fisheries. Of these commissions that of the United States stands in the front rank by virtue of its positive results. But in the near future individual attention must be turned to supplementing the terrestrial resources, the wheat fields, the cattle and sheep ranches, by an increasing utilization and development of the possibilities of marine farming; by fish propagation, by plantations of oysters, clams, quahaugs and scallops, by raising herds of lobsters and crabs. Improved breed of fish, of lobsters will result. The possibilities are well-nigh limitless; and by cultivation of the sea and sea bottom as well as of the land, man will postpone indefinitely the fulfillment of the Malthusian prophecy.

But conditioning all advance in the possibilities of marine cultivation is the knowledge of the Plankton, of its distribution, and of the fundamental basis of marine life, the microscopic marine organisms in the ocean.

IMPORTANCE OF THE SCIENCE AND OF THE DEPARTMENT OF PREHISTORIC ANTHROPOLOGY.

By Thomas Wilson.

(*Continued from page 689.*)

The International Congress of Anthropology and Prehistoric Archeology held its Eleventh session in Moscow during August, 1892. This Congress was organized and has been holding its regular sessions since 1865 or '67. It has had delegates from all neighboring countries; they have usually met in the capital of the country, and never twice consecutively in the same country, with a number of members varying from 500 to 1500, according to the contiguity of the place of meeting. Their bulletins have formed volumes of several hundred pages (that at Stockholm over a thousand), yet no scientific organization from the United States has ever had any representative, and since the meeting in Paris in 1878 there have not been three citizen representatives of the United States at any one of the meetings. The same comparison continued with regard to the means of instruction in the different countries, America and Europe would make about the same showing. Each of the countries of Europe may, I think, fairly claim that they are equal to, if not ahead of, the United States in their appreciation of and assistance to the science of Prehistoric Anthropology; even little Switzerland, with a territory of 16,000 square miles, would say she was not behind us. France, with her area of 204,000 square miles, would undoubtedly claim superiority over the United States. The area of the United States is greater by far than that of all Europe, and its archæologic field, acre for acre, is equally rich in specimens, and would afford a proportionate number and a proportionately good opportunity for the study of the history of the prehistoric man, and yet I repeat, every country in Europe, if it but knew the exact status in the United States,

would claim that it was superior in interest and study of the science of Prehistoric Anthropology.

In the means of education in this new science the same comparison holds good between Europe and the United States. In the societies of the different countries, established for the advancement of science, a section is devoted to anthropology, as is done in the United States. But the ten different countries of Europe make ten different societies there against one in America. In France, Germany, Italy, Denmark, Sweden, Scotland, and possibly in England, though I cannot say certainly, there have been courses of lectures organized and conducted in connection with the societies of anthropology and the museums (such as comprise my department), in nearly all the principal cities. I may mention that of Paris as the most extensive and complete, yet the others are of no mean proportion. In Paris the organization comprises eleven lecturers, each one lecturing once each week (eleven lectures per week), during the entire college season from October until June, all being upon the subject of Anthropology. The lecturers are paid for their services and they carry on their work continuously and with an earnest diligence for which we can find few parallels in the United States. The good effects of these lectures and of this education is manifested in the interest taken in the society which numbers at Paris nearly 700 members, with an annual income of 20,000 or more francs, and with a capital reserve of over 50,000 francs.

The following is the program of weekly lectures for the present year 1891–92.

Prehistoric Anthropology, M. Gabriel de Mortillet; Somatology, Mathias Duval; Geographic Anthropology, M. Fr. Schrader; Ethnography and Language, M. André Lefevre; Ethnology, M. Georges Hervé; Biologic Anthropology, M. J. V. Laborde; Zoologic Anthropology, M. Mahoudean; Medical Geography, M. Dr. A. Bordier; Physiological Anthropology, Dr. Manouvrier; History of Civilization, Dr. Letourneau; Comparative Ethnology, M. Adr. de Mortillet.

Any mention of similar efforts or labors in the United States would surely omit some institutions or persons despite

the best intentions and the greatest care, or might under- or over-rate those noticed.

Readers within the United States will be acquainted with these efforts, and it would serve no purpose to tell them what they already know. To avoid possible complications arising from unintentional omissions or misunderstood comparisons no statement of this work in the United States is attempted.

Enlarging upon this question of the comparative want of interest on the part of the United States Government and people, I might remark the number of missions which have been sent out by these European governments in pursuit of this science. In 1884–'85 France sent Dr. Poussie to Australia and India to make studies in ethnography, Le Bon to India to study primitive architecture, Jules Monsier to make archæological researches in Caucausus, De Morgan to Armenia, Monsieur Brau to Malacca and Sumatra to make ethnographic collections, Gauthier to Turkey and Persia for researches in natural history and anthropology. Ernest Chantre, Curator of the Prehistoric Museum at Lyon, was sent by the Government to make anthropological researches in the Caucausus. He has published his report in five large volumes, quarto, with 446 figures and 140 chromo-lithographic or heliographic full page plates. M. Cartailhac was sent on a like mission to Spain and Portugal. His report is published in a large volume with 450 engravings and four plates. The most extensive and complete works, with the finest illustrations concerning our own country do sometimes come from the hands of these foreigners thus sent out. Weiner reports Peru, Lucien Briart the Aztecs, while the most comprehensive work on the subject entitled "Prehistoric America," is written by a Frenchman, Marquis Nadaillac.

The Curators of European museums are being continually sent to visit and examine other prehistoric museums than their own. In a report published by the keeper of the National Museum of Antiquities at Edinburgh, Dr. Anderson and his assistant, Mr. Black, is to be found a note of some of these visits. In connection with most of the principal archæological museums on the continent, provision has been made

for enabling the officers and attaches of the museum to enlarge their knowledge in the lines of their specialties by travel and research. In 1842–'45 Worsaae was sent from Copenhagen through Sweden, Norway, North Germany and Russia; in 1846–'47 to Great Britain, and the result was the publication of his "Danes and Northmen in Britain," which is still the standard work. Mr. Undset, an attache of the Christiana Museum, was sent to Sweden, Denmark, Germany, France and Britain, as a result of which he published his "Norse Antiquities." Since then he has traveled over Europe and published his report, "The Iron Age in Europe," the standard book on that subject. In 1878–'79 Dr. Sophus Muller, an attache of the Prehistoric Museum at Copenhagen, was sent through Germany, Austria and Italy, returning through France and Britain. He studied the Zoomorphic Ornament in Europe and has published a complete monograph on the subject. Dr. Montelius, of the National Museum at Stockholm, was sent throughout Europe to study the "Fibulæ of the Bronze and Iron Ages." Sweden and Norway each set aside $560 annually for similar purposes. The report of Dr. Anderson which I have just mentioned, was the result of sundry voyages made throughout Scotland, visiting the local archæological museums for the expenses of which an annual appropriation of $200 has been made.

The closer we examine and study the policy of the European governments and compare their achievements and those of their people and institutions with those of Government and kindred institutions in the United States, the greater the contrast. Take the laws of the various European governments for the preservation of by obtaining title to mounds, earthworks, caves, dolmens, and other prehistoric monuments. The most of the European countries have passed such laws. In England Stonehenge is under the care of the government, and Abury is in the same line if the transfer has not been actually completed. Denmark, Sweden and Norway own great numbers of prehistoric monuments. In France they are to be counted by the hundreds, while Italy probably surpasses all others. In Italy these matters have received most serious

consideration at the hands of the Government, and a complete system of laws are now in force providing for the proper investigation of these monuments, their preservation and the conservation of the objects found therein. Any person in the Kingdom making a discovery of archæological objects is required to make it known to the proper department of the Government at Rome. If he would excavate he must also notify the Government, and it will send an inspector who will supervise the excavation, keep a diary of all work done and a register of all objects found. This he does from actual observation, for he is required to be on the ground every day during the progress of the work.

At Corneto-Tarquini the excavations have been continued for twelve years, practically by the same band of workmen under pay of the town with a permanent Government inspector. All objects found are registered and reported to the Government. Nothing will show the contrast between the interest in these matters shown by the Government of Italy and that of the United States better than to tell the purpose of this register. It is that the Government may have control over the objects; that if they be desired by the Government for any of its museums it may have the prior right to purchase at a fair valuation, and if the objects be sufficiently rare and valuable from an artistic or scientific point of view it may prohibit and prevent their exportation and consequent loss to the country.

The United States, so far from having any such governmental control over or interest in any of the prehistoric antiquities, whether monuments or otherwise, has had no serious thought of such control. Neither the Government nor any of its officers or institutions have ever, to my knowledge, even considered a proposition for the purchase of any of these prehistoric monuments, and if they or any of them have ever supervised or inspected an excavation it certainly has not been with a view to purchase the objects that they might be displayed in any of the museums. No officer or institution of the United States has either power or authority to purchase real estate, whether it be a prehistoric monument or not.

No such power has ever been given by Congress, and our position to-day upon this subject is such that the Smithsonian Institution, which may fairly claim to be the representative scientific institution of the Government, cannot purchase any of our numerous prehistoric monuments for the preservation (as was done in the case of the Serpent Mound in Ohio) for want of the necessary legal authority. More than that, it cannot accept and hold the title to any such monument, however great its value or necessity of its preservation, even if presented as a gift.

In all the investigations and publications made by or in the United States concerning prehistoric man, the almost sole object of their investigation and report has been the American Indian. It was Indian first, last, and all the time. The Indian which they investigated was as modern and historic as he was ancient and prehistoric, and in the investigations the former view was kept more prominent than the latter; indeed the latter has been almost entirely overlooked. Even much of the investigation among the mounds has been to prove their modern construction, their relation to the modern Indian, and to show that if not entirely made since the discovery of the continent by Columbus, they have continued from such a short time previous as to be practically of that epoch.

These comments are not made in a spirit of complaint or reproach, but to confirm the statement that our Government and people have not taken the interest in prehistoric researches that has been exhibited by those of Europe. And the comparison has been forced upon the attention of the writer from a personal observation made during several years in European countries.

The duty of investigating prehistoric man of the United States clearly belongs to the scientists of our country. It is the history of our own people and country depending upon the investigations to be made upon our own soil; a studying, and if need be the excavation of monuments erected upon our own territory. If it is to be done at all it should be done by us. True, there is no legal obligation requiring us to make these investigations or perform this labor, and naught but

national pride and our own self-respect will compel it. We should here apply to science, the Monroe Doctrine of politics. We should recognize and declare our own ability to do this work, and our intention to perform it—that we may contribute to the science of the world a history of our prehistoric people. If the work is not to be done by us or if it be insufficiently performed it should not be because the matter was neglected or forgotten by either our government or people, but for the reason we decided it was not worth the effort, and in this way we must justify ourselves in the eyes of the world.

The sciences of Mathematics, Philosophy, Astronomy, Chemistry, Metallurgy, Classic Literature and Archæology, those general and not local, have recognition, but their claims rest upon other countries with equal weight as upon ours. Our country is under no greater obligation in respect of these and similar sciences than are other countries of the world. But in respect of the Prehistoric Anthropology of this country it is different. The duty rests solely upon us. The Smithsonian Institution and National Museum stand as beacon-lights to the American people, and are the representative scientific institutions of our country. In this regard they stand for the United States Government and speak for it. They have the ear of its Executive and of its Legislatures, and exercise an influence with the Government not possessed by private individuals or organizations; and, therefore, a certain responsibility rests upon them whether they will or not.

As a means of correcting the defect mentioned I would respectfully suggest the giving of greater attention to the dissemination of information among the people. This can be done through publications, by means of lectures and by the organization of kindred societies for concert of action and more expensive preparation at their meetings for the presentation of this subject in its proper light. I would also suggest the preparation of specimens illustrating the science of Prehistoric Anthropology, accompanied with descriptive letter press and catalogues,[1] these to be distributed to all institutions

[1] I have prepared during the past year, under the direction of the Smithsonian Institution, 100 sets of typical prehistoric implements for exchange.

of learning in the United States, receiving in exchange such implements and objects as are possible. Perhaps the most important factor of all would be the endeavor to increase the knowledge and interest of the executive and legislative officers of our Government so that the science of Prehistoric Anthropology would receive in the future their countenance and support.

Applying this argument, I suggest that if any department in the National Museum is to be extended or enlarged, is to have greater opportunities for research, more help employed, more money expended, either in publications, illustrations, investigations or in the purchase and display of rare or fine specimens it should be that of Prehistoric Anthropology rather than any other.

THE COMPARATIVE PHYSIOLOGY OF RESPIRATION.[1]

BY SIMON H. GAGE.

Among the very first of the physiological acts observed were those of respiration. The regular movements of breathing, from the first feeble efforts of the new-born babe until the sigh in the last breath of the dying—after which is silence, cold and dissolution—have commanded the attention and claimed the interest of every-one, the thoughtful and the thoughtless alike. And one comes to feel that in some mysterious way "the breath is the life." But in what way does breathing subserve life or render it possible? Aristotle and the naturalists of the olden time supposed that it was to cool the blood that the air was taken into the lungs, and, as they supposed, also into the arteries. With the limited knowledge of anatomy in those early days and the fact that after death the arteries are wholly or almost wholly devoid of blood, while the veins are filled with it, what could be more natural than to suppose that the arteries were vessels for the cooling air. If one supposes that he has entirely outgrown this view of Aristotle let him think for a moment how he would express the fact that an individual is descended from the Puritans, for example. In expressing it even the physiologist could hardly bring himself to say other than "he has the blood of the Puritans in his veins." Would he ever say "he has the blood of the Puritans in his arteries?"

As observation increased the cold blooded animals were more carefully studied and found to possess also a respiration; they certainly do not need it to cool the blood. Then there are the insects and the other myriads of living forms that teem in the oceans, lakes, rivers and even in the wayside pools. Do these too, have a breath? And the plants on the land and

[1]Address by Prof. Simon Henry Gage, of Cornell University, Ithaca, N. Y., Vice-President of the Biological Section of the American Association for the Advancement of Science, Rochester, August 17, 1892.

in the water, is the air vital to them? Aristotle and the older naturalists could not answer these questions. To them, on the respiratory side at least, all life was not in any sense the same.

It was not until chemistry and physics were considerably developed, not until the air-pump, the balance and the burette were perfected that it was possible to give more than a tentative answer. Not until the microscope could increase the range of the eye into the fields of the infinitely little, was it possible to form even an approximately correct conception. The first glimmerings of the real significance of respiration for all living things was in the observation that the air which would not support a flame, could not support life, although it might be breathed. That is, there must be something in the transparent air that feeds the flame and becomes the breath of life, the real *pabulum vitæ,* the merely mechanical action of the air not being sufficient.

Since the experiments on insects and other animals with the air-pump by Boyle (1670), by Bernuilli on subjecting fishes to water out of which all the air had been boiled, and those of Mayow (1674), it became more and more evident that respiration was not confined to the higher forms but was a universal fact in the organic world. Then came the most fruitful discoveries of all, made by the immortal Priestley (1775–6), viz., that the air is not an element but composed of two constituents, nitrogen, which is inert in respiration, and oxygen, which is the real vital substance of the air, the substance which supports the flame of the burning candle and the life of the animal as well.

What would seem more simple at this stage of knowledge than that the parallel between the burning candle and the living organism should be thought to represent truly the real conditions? That as the candle consumes the oxygen in burning and gives out carbon dioxide, so the living thing breathes in oxygen and gives out in place of that consumed, carbon dioxide. And as in each case heat is produced, what would be more natural than to look upon respiration as a simple combustion? This was the generalization of Lavoisier (1780–89). As he saw it, the oxygen entered the lungs, reached the blood

and burned the carbonaceous waste there found and was immediately given out in connection with the carbon with which it had united; and as the gas given off in a burning candle makes clear lime water turbid, so the breath produces a like turbidity.

But here, as in many of the processes of nature, the end products or acts were alone apparent, and while the fundamental idea is probably true that respiration is, in its essential process, a kind of combustion or oxidation, yet the seat of this action is not the lungs or blood. If the myriads of microscopic forms are considered, these have no lungs, no blood, and many of them even no organs; they are, as has been well said, organless organisms, and yet every investigation since the time of Vinci and von Helmont, Boyle and Mayow, has rendered it more and more certain that every living thing must in some way be supplied with the vital air or oxygen, and that this is in some way deteriorated by use. The nearer investigation approaches to the real life stuff or protoplasm, it alone is found to be the true breather, the true respirer. And further, as was shown long ago by Spallanzani (1803–1807), if one of the higher animals, as a frog, is decapitated and some of its muscle or other tissue exposed in a moist place it will continue to take up oxygen and give out carbon dioxide, thus apparently showing that the tissues of the highly organized frog may, under favorable conditions, absorb oxygen directly from the surrounding medium, and return to it directly the waste carbon dioxide. This proves conclusively that it is the living substance that breathes, and the elaborate machinery of lungs, heart and blood-vessels is only to make sure that the living matter, far removed from the external air shall not be suffocated. Still more strange, it has been found that if some of the living tissue is placed in an atmosphere of hydrogen or nitrogen entirely devoid of oxygen, it will perform its vital functions for a while, and although no oxygen can be obtained it will give off carbon dioxide as in the ordinary air. If it is asked how can these things be? the answer is apparently plain and direct. Not as the oxygen unites directly with the carbon in the burning

candle does it act in the living substance. The oxidations are not direct in living matter as in the candle, but the living matter first takes the oxygen and makes it an integral part of itself, as it does the carbon and nitrogen and other elements; and finally when energy is to be liberated, the oxidation occurs, and the carbon dioxide appears as a waste product.

The oxygen that is breathed to-day, like the carbon or the nitrogen that is eaten, may be stored away and represent only so much potential energy to be used at some future time in mental or physical action.

So far only living animal substance has been discussed. If plants are considered what can be said of their relations to the air? The answer was given in part by Priestley (1771), who found that air which had been vitiated by animal respiration became pure and respirable again by the action of green plants. He thus discovered the harmonizing and mutual action of animals and plants upon the atmosphere; and there is no more beautiful harmony in nature. Animals use the oxygen of the air and give to it carbon dioxide, which soon renders it unfit for respiration; but the green plants take the carbon dioxide, retain the carbon as food, and return the oxygen to the air as a waste product. This is as thoroughly established as any fact in plant physiology, and yet in his work Priestley had some which he called "bad experiments," for instead of the plants giving out oxygen and purifying the air they sometimes gave off carbon dioxide, and thus rendered it more impure, after the manner of an animal. What investigator cannot sympathize with Priestley when he calls these "bad experiments?" They appeared so rudely to put discord into his discovered harmony of nature. But nature is infinitely greater than man dreams. The "bad experiments" were among the most fruitful in the history of scientific discovery. Ingenhausz (1787) followed them up, carefully observing all the conditions, and found that it was only in daylight that green plants gave out oxygen; in darkness or insufficient light they conducted themselves like animals, taking up oxygen and giving out carbon dioxide.

Finally it was proved by Saussure (1804) and others that for green plants, and those without green, like the mushrooms, oxygen is as necessary for life as for animals. It thus became evident that this use of oxygen and excretion of carbon dioxide was a property of living matter, and that the very energy that set free the oxygen of the carbon dioxide was derived from oxidations in the green plant comparable with those giving rise to energy in animals. Further, that the purification of the air by green plants in light is a separate function—a *chlorophyll function*, as it has been happily termed by Bernard—and resembles somewhat digestion in animals, the oxygen being discarded as a waste product. Indeed, so powerful is the effort made to obtain oxygen for the life processes by some of the lowest plants, the so-called organized ferments, that some of the most useful and some of the most deleterious products are due to their respiratory activity. In alcoholic fermentation, as clearly pointed out by Pasteur and Bernard (see 3 of references), the living ferment is removed from all sources of free oxygen, and in the efforts of the ferment for respiration the molecules of the sugar are decomposed or rearranged, and a certain amount of oxygen set free; and this oxygen supplies the respiratory needs of the ferment.

It has been found that the motile power of some bacteria, like *Bacterium termo*, depends on the presence of free oxygen in the liquid containing them. When this is absent they become quiescent. This fact has been utilized by Engelmann and others in the study of the evolution of oxygen by green and other colored water plants, the bacteria serving as the most delicate imaginable oxygen test; so that when the minutest green plant is illuminated by sufficient daylight the previously quiescent bacteria move with great vigor and surround it in swarms. Out of the range of the plant the bacteria are still or move very slowly as if to conserve the minute energy-developing substance they have in store until it can be used to the best advantage.

May we not now approach the problem directly and answer for the whole organic, living world the question, "What is

respiration?" by saying *it is the taking up of oxygen and the giving out of carbon dioxide by living matter.* This is the universal and essential fact with all living things, whether they are animals or plants, whether they live in the water or on the land. But the ways by which this fundamental life process is made possible, the mechanisms employed to bring the oxygen in contact with the living matter and to remove the carbon dioxide from it are almost as varied as the groups of animals, each group seeming to have worked out the problem in accordance with its special needs. It is possible, however, in tracing out these complex and varied methods and mechanisms to discover two great methods, the *Direct* and the *Indirect.* (See 8 of references.)

In the first there is the direct assumption of oxygen from the surrounding medium, and the excretion of carbon dioxide directly into it. The best examples of this are presented by unicellular forms like the amœba where the living substance is small in amount and everywhere laved by the respiratory medium. But as higher and higher forms were destined to appear, evidently the minute, organless amœba could not in itself realize the great aim toward which Nature was moving. There must be an aggregation of amœbas, some of them serving for one purpose and some for another. Like human society, as civilization advances, each individual does fewer things, becomes in some ways less independent, but in a narrow sphere acquires a marvellous proficiency. Or to use the technical language of science, in order to advance there must be *aggregation of mass, differentiation of structure and specialization of function.* Evidently, however, if there is an aggregation of mass, some of the mass is liable to be so far removed from the supply of oxygen and the space into which carbon dioxide can be eliminated that it is liable to be starved for the one and poisoned by the other. Nature adopted two simple ways to obviate this, first to form its aggregated masses in the shape of a network or sponge, with intervening channels through which a constant stream of fresh water may be made to circulate, so that each individual cell of the mass could

take its oxygen and eliminate its carbon dioxide with the same directness as its simple prototype, the amœba.

But in the course of evolution forms appeared with aerial respiration; and the insects among these solved the mechanical difficulty of respiration by a most marvellous system of air tubes or tracheæ extending from the free surface, and therefore from the surrounding air, to every organ and tissue. By means of this intricate network air is carried and supplied almost directly to every particle of living matter. The respiration is not quite direct with the insects, however, for the oxygen and carbon dioxide must pass through the membranous wall of the air tube before reaching or leaving the living substance.

In the next and final step, the step taken by the highest forms, the living material is massed, giving rise not only to animals of moderate size, but to the huge creatures that swarm in the seas, or walk the earth like the elephant. With all of these the step in the differentiation of the respiratory mechanism consists in the great perfection of lungs or gills, and in the addition of a complicated circulatory system with a respiratory blood, one of the main purposes being, as the name indicates, to subserve in respiration by carrying to each individual cell in the most remote and hidden part of the body the vital air, and in the same journey removing the poisonous carbon dioxide.

This has been called *Indirect Respiration*, because the living matter of the body does not take its oxygen directly either from air or water, but is supplied by a middle man, so to speak.

The complicated movements by which water is forced over the gills or by which the lungs are filled and emptied, and the great currents of blood are maintained; that is, the striking and easily observed phenomena of respiration are thus seen to be only superficial and accessory, only serve as agents by which the real and the essential processes that go on in silence and obscurity are made possible (see references).

So far I have attempted to give a brief resumè of the views on respiration that have been slowly and laboriously evolved

by many generations of physiologists, each adding some new fact or correcting some misconception; and I trust that this brief sketch has recalled to your minds the salient facts in our knowledge of respiration, and that it will give a just perspective and enable me, if I may be permitted, to briefly describe what I believe to be my own contribution to the ever accumulating knowledge of this subject.

In 1876–1877 Prof. Wilder (6–7), who may be said to have inherited his interest in the ganoid fishes directly from his friend and teacher, Agassiz, who first recognized and named the group, was investigating the respiration of the forms *Amia* and *Lepidosteus*, common in the great lakes and the western rivers. As his assistant it was my privilege to aid in the researches and to acquire the spirit and methods, as in no other way is it so readily possible, by following out, from the beginning to its close, an investigation carried on by a master. The results of that investigation were reported to this section in 1876, and form a part of the proceedings of the Association for that year. From that time until the present the problems of respiration in the living world have had an ever-increasing fascination for me, and no opportunity has been lost to investigate the subject. The interest was greatly increased by the discovery that a reptile—the soft-shelled turtle—did not conform to the generalizations in all the treatises and compendiums of zoology, which state with the greatest definiteness that all reptiles, without exception, are purely air breathing, and throughout their whole life obtain their oxygen from the air and never from the water. The American soft-shelled turtles (*Amyda* and *Aspidonectes*), at least, do not conform to this generalization, but on the contrary naturally and regularly breathe in the water like a fish, as well as in the air like an ordinary reptile, bird or mammal (8).

In carrying on the investigation of the respiration of the turtle there appeared for solution the general problem, which, briefly stated, is as follows: In case an animal breathes in both air and water, or, more accurately, has both an aerial and an aquatic respiration like the ganoid fishes *Amia* and *Lepidosteus*, like the soft-shelled turtles, the tadpoles and many other forms,

what part of the respiratory process is subserved by the aqueous and what by the aerial part of the respiration? So far as I am aware this problem had not been previously considered. It was apparently assumed that there were in these fortunate animals two independent mechanisms, both doing precisely the same kind of work, that is, each serving to supply the blood with oxygen and to relieve it of carbon dioxide as though the other was absent. That was a natural inference, for with many forms the respiration is wholly aquatic, all the oxygen employed being taken from the water and all the carbon dioxide excreted into it. On the other hand, in the exclusively air breathing animals, as birds and mammals, the respiration is exclusively aerial.

This natural supposition was followed in the first investigations on the respiration of the soft-shelled turtles, and while it was proved with incontestible certainty that they take oxygen from the water like an ordinary fish, that is, have a true aquatic in addition to their aerial respiration; there was altogether too much carbon dioxide in the water to be accounted for by the oxygen taken from it. Furthermore, upon analyzing the air from the lungs of a turtle that had been submerged some time the oxygen had nearly all disappeared and but very little carbon dioxide was found in its place, while, as compared with human respiration for example, a quantity of carbon dioxide nearly as great as that of the oxygen which had disappeared, should have been returned to the lungs. Likewise in Prof. Wilder's experiments with *Amia* (7), to use his own words: "Rather more than one per cent. of carbon dioxide is found in the normal breath of the *Amia*, but much more of the oxygen has disappeared than can be accounted for by the amount of carbon dioxide." Everything thus appeared anomalous in this mixed respiration, and instead of a clear, consistent and intelligible understanding of it there seemed only confusion and ambiguity. Truly these seemed like "bad experiments."

It became perfectly evident that the first step necessary in clearing the obscurity was to separate completely the two respiratory processes, to see exactly the contribution of each

mechanism to the total respiration. But this was no easy thing to do. In the first place the animal must be confined in a somewhat narrow space in order that the air and water which are known to have been affected by its respiration may be tested to show the changes produced in it by the respiratory process; in the second place the water has so great a dissolving power upon carbon dioxide that even if it were breathed out into the air it would be liable to be absorbed by the water; then some means must be devised to prevent the escape of the gases from the water as their tension becomes changed; and finally, the animal in the water must be able to reach the air. A diaphragm must be devised which would prevent the passage of gases between the air and water, and at the same time offer no hindrance to the animal in projecting its head above the water. As a liquid diaphragm must be used it occurred to me that some oil would serve the purpose; but the oil must be of peculiar nature; it must not allow any gases to pass from air to water or the reverse, it must not be in the least harmful or irritating to the animal under experimentation, and finally it must itself add nothing to either air or water. Olive oil was thought of and later the liquid paraffins. The latter were found practically impervious to oxygen and fulfilled all the other requirements, but unfortunately they absorb a considerable quantity of carbon dioxide. Pure olive oil was finally settled upon as furnishing the nearest approximation to the perfect diaphragm sought.[2]

The composition of the air being known, and a careful determination of the dissolved gases in the water having been made, the animal was introduced into the jar, and the water covered with a layer of olive oil from ten to fifteen millimeters thick. The top of the jar was then vaselined, and a piece of plate-glass pressed down upon it, thus sealing it hermetically. Two tubes penetrate this plate-glass cover, one connecting with the overlying air chamber and the other extending into the water nearly to the bottom of the jar. As the water and air were limited in quantity the shorter the time in which the ani-

[2]See Wm. Thörner on the use of olive oil for the prevention of the absorption of carbon dioxide. Repetorium der analytischen Chemie, 1885, pp. 15–17.

mal remained in the jar the more nearly normal would be the respiratory changes; the experiments were, therefore, continued only so long (one or two hours) as was found necessary to produce sufficient change in the air and the dissolved gases of the water to render the analysis unmistakable.

Proceeding with the method just described the results given in the following table were obtained:

Table of mixed respiration showing the number of cubic centimeters of oxygen removed from air und water, and the amount of carbon dioxide added to the air and the water.

	Oxygen.		Carbon Dioxide.	
	From air.	From water.	To air.	To water.
Ganoid fish (*Amia calva*) . .	65	10	22	53
Tadpoles (*Larval batrachia*) .	70	5	24	51
Soft-shelled turtle (*Amyda mutica*)	31	8	10	29
Bull frog (*Rana catesbiana*) .	183	4	110	77[3]

It requires but a glance at the figures in this table to see that the aerial differs markedly from the aquatic part of the respiration. Even in the frog, in which the skin forms the only aquatic respiratory organ, the tendency is marked. The law appears to be unmistakably this, viz., *that in combined aquatic and aerial respiration the aerial part is mainly for the supply of oxygen and the aquatic part largely for the excretion of carbon dioxide.* This law, which I stated in 1886 (8), has been

[3]The oxygen from both the water and the air and the carbon dioxide in the air were determined with exactness in all the experiments; but owing to the failure of some steps in the titration for the carbon dioxide in the water, the figures given for the *Amia* and the soft-shelled turtle are the calculated results, assuming that the respiratory quotient is one, as that is the relation found by analysis in the other cases. This table will be greatly extended when the results of the investigation now in progress are published.

confirmed by the repetition of old experiments and by many new ones during the present summer; it is also confirmed by the experiments made on *Lepidosteus* in a different way by Dr. E. L. Mark (9), and published in 1890. I therefore feel confident that this is the expression of a general physiological law in nature.

From the standpoint of evolution we must suppose that all forms originated from aquatic ancestors, ancestors whose only source of oxygen was that dissolved in the water. As the water is everywhere covered with the limitless supply of oxygen in the air, there being 209 parts of oxygen in 1000 parts of air as contrasted with the 6 parts of oxygen dissolved in 1000 parts of water, it is not difficult to conceive that in the infinite years the animals found by necessity and experience that the needed oxygen was more abundant in the overlying air, and that some at least would try more and more to make use of it. And as any thin membrane with a plentiful blood supply may serve as a respiratory organ to furnish the blood with oxygen, it is not impossible to suppose that such a membrane, as in the throat, could modify itself, little by little, with ever increasing efficiency; and that a part might become especially folded to form a gill and another might become sacular or lung-like to contain air. While I am no believer in the purely mechanical physiology which sees no need of more than physics and chemistry to render possible and explain all the phenomena of life, yet it is patent to everyone that although vital energy is something above and beyond the energies of physics and chemistry, still it makes use of those; and certainly dead matter forms the material from which living is built. So given a living thing, it in most cases moves along lines of least rather than greatest resistance, therefore if practically a limitless supply of oxygen may be obtained from the air and only a limited amount from the water, if any thing that might serve as a lung is present, most naturally the animal will take the oxygen from the air where it is in greater abundance and most easily obtained. On the other hand carbon dioxide is so soluble in water that practically a limitless amount may be excreted into it; and as it is

apparently somewhat easier, other things being equal. for it to pass from the liquid blood to the water than to the air it seems likewise natural that the gills should serve largely for the excretion of the carbon dioxide into the water. This is the actual condition before us in these, and I believe in all other cases, of mixed or of combined aerial and aquatic respiration. And I believe the fundamental law in respiration is, as stated above that whenever both water and air are used with corresponding respiratory organs, *the aerial part of the respiration is mainly for the supply of oxygen and the aquatic part largely for the getting rid of carbon dioxide.*

It is not difficult to see in an actual case like that of the Ganoid fishes (*Amia* and *Lepidosteus*) the logical steps in its evolution, by which this most favorable condition has been reached. A condition rendering these fishes capable of living in waters of almost all degrees of purity, and thus giving them a great advantage in the struggle for existence. But what can be said of the soft-shelled turtles, animals belonging to a group (Reptilia) in which purely aerial respiration is almost exclusively the rule? Standing alone this might be exceedingly difficult or impossible of explanation. The Batrachia (frogs, toads, salamanders, etc.,) all have gills in their early or larval stage, and most of them develop in the water, and are in the beginning purely aquatic animals. The adults must, therefore, in most cases repair to the water at the spawning season, and frequently in laying the eggs they must remain under the water for considerable intervals. Being under the water and the need of oxygen becoming pressing, there seems to be, by a sort of organic memory, a revival of the knowledge of the way in which respiration was accomplished when as larvæ their natural element was water, and they may take water into the mouth and throat. This may be done by as highly a specialized and purely aerial form as the little brown tree-frog (*Hyla pickeringii*) or the yellow-spotted salamander (*Amblystoma punctatum*). Another very interesting form, the vermilion-spotted newt (*Diemyctylus*), after two or three years of purely aerial existence, goes to the water on reaching maturity, and remains there the rest of its life, regularly

breathing both by its lungs and by taking water into its mouth. A still more striking example is given by Prof. Cope. The young Siren almost entirely loses its gills and later regains them, becoming again almost as completely aquatic in its habits as in the larval stage.

With these examples which may be seen by any one each recurring year, is it impossible or difficult to conceive that in the struggle for existence the soft-shelled turtles found the scarcity of food, the dangers and hardships of the land, greater than those in the water? On remaining constantly in the water, and advantageously submerged for most of the time, it gradually reacquired the power of making use of its pharingeal membrane for obtaining oxygen from the water and excreting carbon dioxide into it as had its remote ancestors. And further, is it not intelligible that with capacious lungs, which it can fill at intervals with air containing so large a supply of oxygen that it, like the other double or mixed breathers, should use its lungs to supply most of the oxygen and its throat to get rid of much of the carbon dioxide?

Indeed, it seems to me that if the evolution doctrine is a true expression of the mode of creation, then development may be in any direction that proves advantageous to an organism, even if the development is a re-acquirement of long discarded structures and functions (11).

In closing may I be permitted to say to the older biologists, to those familiar with the encouragements and inspirations that come with original investigation, that I trust they will pardon what to them is unnecessary personality or excess of detail in this address for the sake of the younger ones among us, to whom the up-hill road of research is less familiar. Judging from my own experience in listening to similar addresses by my honored predecessors, it is helpful to know, when one is beginning, something of the "*dead work*," the difficulties and discouragements as well as the triumphs in the advancement of science.

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EDITORIALS.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

—The meeting of the American Association for the Advancement of Science, which closed its session at Rochester, August 23, was remarkable for several things. One characteristic was the large preponderance of papers in the biological section. Not only was this section more abundantly supplied with matter than any other, but entomological and botanical clubs also held sessions almost continuously. It seemed to the section that it would not be possible in future to give time for all papers likely to be presented, so it was decided to divide it into a zoological and a botanical section, which should, however, have a joint session to hear papers of general interest. Another feature of the Association was the extraordinary management of the geological section, which seemed to have fallen into the hands of a clique who quite forgot to cooperate with the rest of the Association. The section spent nearly all of one session discussing an excursion which some of the members had taken the day before, in disregard of the printed programme, which announced that certain papers would be read. Numerous persons were much inconvenienced by this proceeding. Another session was adjourned before half the usual term had elapsed, although persons were present fully prepared to read papers as announced in the programme. On another day the alternative was presented the members of remaining after the dinner hour had arrived, or of submitting to a final adjournment, as some of the members had an excursion on hand for the afternoon. In order to finish the programme the section decided to remain and take a late dinner, rather than disoblige the excursionists. But the height of impropriety was reached when the chairman of the section left the meeting and asked the section to elect one of his friends chairman. The section promptly complied. The new chairman then appointed an important committee, in which the late chairman's name occupies a conspicuous place.

The arrangements for the meeting of the Association made by the citizens were excellent, and were carried out without interruption. Discussion of papers was active and interesting, and added much to the interest of the occasion.

—THE American table at the Zoological Station of Naples needs the prompt attention of American biologists. For several years Americans desirous of studying at Naples were dependent on the bounty of foreign governments, whose temporarily vacant tables we used. This state of affairs becoming known, a wealthy resident of Syracuse, N. Y., Major Alex. H. Davis, paid the greater part of the sum ($500) necessary for the rent of the table. Last year over half the amount was raised by subscription among American students and institutions, Major Davis making up the deficiency. As this gentleman is not a specialist in biology it is not to be expected that his subscription will be always forthcoming, and those most interested are asked to make up the entire amount this year. The American Association and the Society of Naturalists have subscribed hitherto, and there is no reason why the Bache Fund of the National Academy should not contribute an important part of the amount. There should be no question of the ability of this nation to support one table at the Biological Station at Naples.

—A RECENT article in "Nature" states that the vertebrate fossils collected by Prof. Marsh for the U. S. Geological Survey are to be shortly exhibited in the National Museum at Washington. Similar communications were made to newspapers in this country about a year ago. As no provision exists for the exhibition of these fossils in the U. S. National Museum these announcements are premature. One side of a small room is the only space at present occupied by the material in question, and it is safe to say that no other space has been yet provided. As the National Museum committed the error at its establishment of attempting an exhibit of modern human industries, as we pointed out at the time, the space for scientific exhibits is necessarily greatly curtailed. The necessities of this department require the erection of a new building, and until that is done it is safe to say that the vertebrate collections of the U. S. Geological Survey will not be exhibited.

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RECENT LITERATURE.

Eimer on the Origin of Striped Muscular Tissue.[1]—Prof. Eimer, of Tübingen, endeavors in this treatise to prove that the transverse striping of muscular tissue is due to increased energy of muscular contraction. He refers to the well-known fact that this character is seen in muscles which display the greatest energy, while the unstriped condition is characteristic of muscles of feeble and slow contractility. This is shown to be the case in many animals, some of the most striking illustrations being drawn from the Mollusca. Among the most important observations are those on the muscles of the Anthropoda. The author made the interesting observation that the thoracic muscles of the house-fly are, during the winter season of torpidity, unstriped, while with the advent of active life in spring the cross-striping appears, and is most developed in summer, the period of greatest activity. The various stages of development of the Zwischenscheiben and Mittlescheiben, which are to be seen not only in the same individual but in the same fibrilla, are traced and illustrated. It is also maintained that the longitudinal division of primitive simple muscular masses into fibrillæ is due to longitudinal stress; and still earlier in evolution that muscular tissue is differentiated from homogenous protoplasm by the same agency. These theses are sustained with much plausibility, and they may be regarded as an integral part of Neolamarckian doctrine. Prof. Eimer expresses his results in the following language: "The cross-banding is the permanent expression of contraction waves of the muscle mass caused by nervous stimulus. It appears to be in the fullest sense an acquired and inherited peculiarity."

Beecher's Studies of the Brachiopoda.[2]—This paper is the second of a series in which are published the results of a combined study of young and adult, living and fossil brachiopods. The facts and conclusions reached are of great interest, and are highly important to a clear understanding of the group.

[1]Die Entstehung und Ausbildung des Muskelgewebes insbesondere der Querstreifung derselbens als Wirkung der Thatigkeit betrachtet; von G. H. Th. Eimer. Separat Abdruck aus Zeitschr. f. wissensch. Zoologie, liii, Suppl. Leipzig, 1892.

[2]Development of the Brachiopoda, Part II. Classification of the Stages of Growth and Decline, by Charles E. Beecher (with Plate 1). Am. Jour. Sci., Vol. xliv, Aug., 1892.

The author applies Prof. Alpheus Hyatt's "Classification of Stages of Growth and Decline" to the brachiopods from the developing of the ovum to the old age of the individual. This classification works so well in this new application that it adds strength to it as a system.

Prof. Beecher reviews the existing knowledge of the embryology of brachiopods, rendering very clearly the progressive development of the shell and associated parts. Kutorgina is suggested as a radical of the strophomenoids. A close comparison is made of the reflected "collar" in developing Spirorbis, with the reflected mantle lobes in Cistella. Thecidium is considered as a surviving member of the strophomenoids, which group has previously been considered as extinct.

Important observations are made on the development of the deltidium, in which the author shows that it is primarily a plate formed on the dorsal side of the posterior or pedicle segment of the larva. In later growth the deltidium becomes ankylosed with the ventral valve, which grows around so as to include it. This conclusion is strengthened by collateral proofs of microscopical structure. Deltidial plates, on the other hand, he shows are developed by the unfolding of the ventral mouth lobes at the pedicle area. They therefore properly belong to the ventral valve.

A perforation in the umbo of the dorsal valve in many early articulate types leads to the conclusion that they had an anus. In brachiopods as a whole some features are progressive, others retrogressive. The protegulum[3] or larval shell is mentioned, but is fully discussed in the earlier paper.

Acceleration of development is clearly shown in Discinisca, which in the nepionic stage adopts characters which are first found in the nealogic stage of its ancestor, Orbiculoidea. Nice distinctions are made between characters acquired by inheritance and those adopted by special adaptations to conditions of environment, which latter may appear anywhere in separate genetic series. Postembryonic stages are briefly considered in types of the four orders proposed by the author.

Old age, or the geratologic period in brachiopods, is marked by the thickening of the valves, and may be further indicated by loss of ornamentation and resorption of the deltidium or deltidial plates. In the early forms of each genus and family the species are small, in the culmination they attain a maximum of size; before extinction they again resume a depauperate size and present abundant geratologous and pathologic forms. As such degraded types. Cistella and Gwynia, among brachiopods, bear such relations to the Terebratuloids as Baculites amongst cephalopods do to the Ammonoids.

ROBERT T. JACKSON.

[3]Comparable to the protoconch and prodissoconch of mollusks.

General Notes.

GEOGRAPHY AND TRAVELS.

The Peary North Greenland Expedition.—This expedition, together with the relief expedition, both sent out by the Academy of Natural Sciences of Philadelphia, has returned safely. They stopped at St. Johns, Newfoundland, and we derive the following report of their proceedings from letters sent to the *Record* and *Ledger* by Lieut. Peary and Mr. Meehan of the expedition,and from information subsequently obtained by ourselves.

Lieut. Peary has carried out his plans fully and made an inland ice journey of 1300 miles with Mr. Astrupp, and, through the members of his party who remained at McCormick Bay, has made a rich collection of the flora, fauna and ethnology of North Greenland, besides which he has demonstrated the ease and comfort with which a winter can be spent in the Arctic regions. The Relief Expedition has been equally fortunate. Not an essential plan projected by Professor Heilprin has miscarried, and many things have been accomplished not considered feasible before sailing. Throughout the voyage no serious mishaps occurred, and the collections made are probably unprecedented, even by many Northern expeditions remaining for a longer period of time. It made an almost complete collection of water and land mammals, both in skins and skeletons; a large variety of birds and submarine animal life, a collection of flowering plants, mosses, lichens and insects, and of ethnological specimens, which is probably only excelled by that in the museum at Copenhagen. This includes tents, costumes, sledges and dogs of the northern Esquimaux. The party has also secured meteorological and tidal observations, and a large number of photographs of natives, dwellings and arctic scenery.

Peary discovered what he went after—the northern boundary of the main mass of Greenland. The details of his journey are awaited with great interest.

The expedition was a success, among Lieutenant Peary's discoveries being one of a great bay, latitude 81.37, longitude 24, opening out east and northeast, which he named Independence Bay, in honor of the day, July 4; and the great glacier flowing north into it,

Academy Glacier, in honor of the Academy of Natural Sciences of Philadelphia, which sent out the expedition.

He succeeded in exploring the great fiords and glaciers emptying into Kane and Hall basins and Robeson channel, and Whale and Inglefield Sounds.

The record of the Peary party from the date of arrival in McCormick's Bay to its leader's return from the inland ice is a pleasant one. The winter quarters were completed soon after the Kite left last year, and named Red Cliff House, from the color of the rocks and Cape Cleveland. Numerous expeditions were made during the autumn to secure fresh meat for winter use. During one of these in August a family of Eskimos was induced to remove to Red Cliff House, and this family subsequently brought several others. These proved valuable aids to the Peary party in carrying out their plans. Mr. Peary's leg, which was broken last year, meanwhile improved rapidly, and by September 29 he was able to abandon crutches. During early autumn two reconnoissances of the inland ice were made, the first on September 7, by Astrupp, Gibson and Verhoeff, occupying five days, and the second on September 23, by Astrupp and Gibson, of seven days duration. The hunting expeditions, which lasted until November 8, when winter regularly set in, were eminently successful, no less than 53 reindeer having been secured, the skins of which were made into garments and sleeping bags. The long winter night was occupied in making sledges and other articles. Although the weather was very cold, the lowest temperature being minus 53 degrees, the party had no difficulty in keeping warm. When spring opened they had more than one ton of coal remaining of the seven tons left them, besides a large quantity of kerosene. The health of the members also was excellent, except during a short period, when Mr. and Mrs. Peary suffered from the grippe.

The sun showed itself on February 15th, and almost immediately provisions were gradually taken to the head of the bay, 15 miles distant, for the ice journey. On April 29th the work of transporting these to the edge of the inland ice began, Mr. and Mrs. Peary, with a few Eskimos, in the meantime taking a short boat journey to Inglefield Gulf to survey it.

On May 8th the ice journey began, the party comprising Peary, Astrupp, Gibson and Cooke—Henson and Verhoeff remaining behind with Mrs. Peary, the first on account of a frozen heel and the second to attend to meteorological work in which he had become greatly interested. At the start seven sledges of different patterns were taken,

but three of these were soon found unavailable and dropped. Twenty Eskimo dogs were also taken, but five of these had died by the time the party had gone 30 miles beyond the basin of the Humboldt glacier, which was reached on May 21st. At this point Mr. Peary selected Astrupp as his companion, took three of the sledges and 13 dogs and continued the journey, Cook and Gibson returning with one sledge and two dogs, arriving at the Red Cliffe House early on the morning of June 3d. After leaving Cook and Gibson, Peary and Astrupp pursued a northeast course, following along the Humboldt glacier, Peterman and Sherard Osborn Fiords, and succeeded in determining the northern boundary of the main land mass of Greenland.

Soon after the commencement of the journey two of the three sledges were discarded, and before its completion eight of the thirteen dogs died. The sledge which was used during the entire journey was ten feet long, sixteen inches wide and weighed thirteen pounds, and sustained without breaking a weight of 450 pounds. The principle food was pemmican, pea soup, bear's meat, tea and biscuit. No tent was used to harbor them from the winds, and even sleeping bags were after a time discarded, the fur clothing being considered sufficient protection for a greater part of the time. The weather was pleasant, except for the sharp winds, and but little difficulty was found by the two in keeping their course, except during fogs, which closely resembled the ice they were travelling on. They succeeded in making the entire journey in ninety days, the return being made in much shorter time than the forward movement.

Shortly after Mr. Peary's return occurred the only catastrophe of the expedition—the disappearance and possible death of Mr. Verhoeff. He was last seen on August 11, when he intimated his intention of visiting a neighboring settlement, a mineral territory well known to him. Having failed to appear within a reasonable time, fears for his safety were aroused and search was begun for him. In this the Peary party, the Relief Expedition and the crew of the Kite were engaged, besides nine Eskimos, who were stimulated to extra exertion by the offer of rifles and other articles valuable to them. The search, which was continued without intermission for seven days and nights, was so thorough that several small articles lost last spring were found, and finally traces of the missing man. There were footprints leading from the shores of Robertson's Bay up to a dangerous glacier. At its head were found a number of mineralogical specimens placed carefully on a rock, with drippings from a meat can and a piece of

string. Besides the heap of minerals, from the evidence discovered there was no doubt in the minds of the searchers that Mr. Verhoeff had been there and had fallen into one of the thousands of dangerous gulches which that glacier possessed, and was killed. Having completely traversed the country that was in any way accessible to Mr. Verhoeff, and convinced themselves of the futility of any further search, the expedition returned to McCormick Bay on the night of August 23, and on the following day started on the homeward journey.

GEOLOGY AND PALEONTOLOGY.

The Elevation of Mount Orizaba or Citlaltepetl.—Citlaltepetl (Star Mountain) is an old volcano situated on the eastern margin of the Mexican table land, about 19° north of the equator and about seventy-five miles from the Gulf. The slopes of the mountain have been known and occupied by man for many centuries, yet from a scientific standpoint they are comparatively unknown.

In July, 1891, a party consisting of Henry E. Seaton, Bloomington, Ind., botanist; A. J. Woolman, South Bend, Ind., icthyologist; W. S. Blatchley, Terre Haute, Ind., entomologist; U. O. Cox, Mankato, Minnesota, ornithologist, and the writer, visited the Star Mountain, making interesting collections of the varied forms of life found on its slopes. The different members of the party will in due time report on the work done in the different departments.

The question of the highest elevation in North America seems to lie between Citlaltepetl in Mexico and St. Elias in Alaska, so that considerable interest centers on the determination of the exact elevation of these mountains.

Different observers vary considerably in their estimates of the elevation of Citlaltepetl; among many the following may be noted:

A. Von Humboldt, 17,375 feet. A Mexican scientific commission, 17,664 feet. Ferrer, 17,879 feet, which is the elevation given by some German geographers. Abmaran, 17,916 feet. Prof. A. Heilprin, 18,205 feet. Dr. Franz Kaska, 18,270 feet.

Prof. Heilprin used an aneroid barometer, adjusted by comparison with a standard mercurial barometer. The elevation of the City of Mexico was determined by railway levels, and the elevation of the summit of the mountain above the City of Mexico was determined by comparing nearly simultaneous barometrical readings, taken one on mountain and one in the city, about 125 miles away. The dis-

tance between the two localities is considerable and the atmospheric conditions are usually very diverse, yet the results are very close to those of Dr. Franz Kaska who used two mercurial barometers, of mountain form, read at about the same time, one on the summit of the mountain and one at Chalchicomula about twenty miles away. The elevation of the datum point in Chalchicomula was determined by railway levels.

From the datum point used by Dr. Kaska, assisted by Mr. O. G. Bunsen I carried a line of spirit levels up to the 14,000 feet level. Higher it did not seem practicable to go, on account of snow, steep slopes, high winds, etc. From that elevation we made two ascents, one on July 29, 1891, and one on August 3, 1891. I used an aneroid barometer adjusted by comparison with a standard mercurial barometer. On each ascent the barometer was read at the summit about 2 o'clock P. M., and at the 14,000 feet level at about 5 o'clock P. M. The readings for July 29, reduced by the method of the U. S. Coast Survey, indicated a difference in elevation between the 14,000 feet level and the summit of 4139.20 feet, while those of August 3 by the same method indicated a difference of 4219.12 feet. The average of these results 4179.16 feet plus 14,000 feet gives a total elevation of 18,179.16 feet, a result surprisingly near that of Prof. Heilprin. Prof. Heilprin estimated that his station was 120 feet below the summit. My aneroid barometer indicated that it was only eighty-six feet below the true summit; subtracting this difference of thirty-four feet from Prof. Heilprin's figures, and the two results 18,171 feet and 18,179 feet differ by only 8 feet.

The atmospheric conditions on July 29 and August 3, to the senses seemed identical, yet the difference as shown by the barometer was considerable, and the barometer, when checked with the spirit level elevations, gave varying results. These variations, while not wide, gave rise to a feeling of uncertainty as to the trustworthiness of the barometer in determining such high elevations.

In April 1892, assisted by Señor E. O. Moreno, I measured a base line 1550 feet long, near the 13,000 feet level and obtained the angles necessary to determine the elevation of the peak above each end of the base line, a large cross planted on the summit forming a definite point of observation. The results show an elevation of 18314.357 feet, as follows:

Railway levels from tide water at Vera Cruz to datum in Chalchicomula	8313.571 feet.
Spirit levels from Chalchicomula to Station A.	4696.188 feet.
Triangulation from Station A.	5302.267 feet.
Elevation via Station A.	18,312.026 feet.
Spirit levels from Chalchicomula to Station B.	4720.569 feet.
Triangulation from Station B.	5282.146 feet.
Elevation via Station B.	18316.687 feet.
Mean elevation	18314.357 feet.

It was a source of great satisfaction to Dr. Kaska and myself to find our results, obtained by different methods, so closely confirmatory and not widely different from the results obtained by Prof. Heilprin and myself with aneroid barometers. From the above results it seems safe to consider Mount Orizaba or Citlaltepetl as being about 18,300 feet high.

Popocatepetl (Smoking Mountain) about 100 miles west of Citlaltepetl is thought by many to be higher than the Star Mountain; but one who has ascended both peaks would certainly consider Citlaltepetl the higher elevation. Prof. Heilprin's observations made Popocatepetl about 700 feet lower than the Star Mountain, and my barometer indicated about the same difference, so that the honor of being the culminating point of North America clearly lies between the Star Mountain of Mexico and Mount St. Elias of Alaska.—J. T. Scovell, Terre Haute, Indiana.

Seeley on the Sauropterygia.—In the Proceedings of the Royal Society of Great Britain, Vol. li, p. 119, Prof. H. G. Seeley, F. R. S., gives a synopsis of the characters of the genera and families of the Sauropterygia which are found in the beds of the Jurassic and Cretaceous systems. He points out the fundamental character of the difference between the structure of the shoulder girdle in the Elasmosauridæ and Plesiosauridæ first insisted on by Cope, and regards the differences between the paradiapophyses of those families as of family significance instead of generic, as held originally by Cope. The previous paper of Prof. Seeley on the structure of the shoulder girdle of the European genera threw great light on the systematic of this order of reptiles, and the present paper increases that knowledge and establishes the taxonomy on a firm basis. He places the long necked and short necked genera in different families, a proceeding which may require revision, although of the generic value of such groups there

can be no doubt. The genera with divided cervical ribs are Plesiosaurus, Eretmosaurus, Rhomaleosaurus and Pliosaurus. Those with simple cervical ribs are Polyptychoden, Polycotylus, Cimoliasaurus, Stereosaurus, Mauisaurus, Elasmosaurus, Trinacromerum, Colymbosaurus, Muraenosaurus, Cryptoclidus. Thaumatosaurus he thinks is identical with Pliosaurus.

Dana on the Huronian System.—In the Amer. Journ. Sci. Arts, Prof. Dana makes some rational observations on the recent proposition of certain members of the U. S. Geological Survey to add a fifth division to the geological system of time under the name of the Algonkian era. He says: "The Algonkian (or Agnotozoic) beds belong either to the Archean or to the Paleozoic. The Archean division of geological time is of the same category with the Paleozoic, Mesozoic and Cenozoic; all are grand divisions based on the progress of life, and they include together its complete range. There is no room for another grand division between Archean and Paleozoic any more than for one between Paleozoic and Mesozoic. The so-called Algonkian is not above Cambrian in grade, it being based on series of rocks. Its true biological relations are in doubt, because fossils representing the supposed life of the period are unknown or imperfectly so. The discovery in any rocks so-called, of Trilobites, Crustaceans, Molluscs, Brachiopods or Crinoids, whatever the species, would entitle such rocks to a place in the Paleozoic, and either within the Cambrian group or below it. Walcott has already reported such fossils from the beds at the bottom of the Colorado canyon referred by him to the Algonkian, namely: besides a Stromatopoid, a small Patella-like or Discina-like shell, a fragment of a Trilobite and a small Hyolithes, forms which make the beds Paleozoic beyond question" (p. 460, June No., 1892).

Geological News.—Mr. Whitman Cross, in a late number of the Amer. Journ. Sci. Arts, endeavors to set forth the state of our knowledge of the stratigraphy and incidentally paleontology of the Laramie formation. He thinks it probable that the alleged Laramie includes several formations, which are distinguished by unconformity and lithological diversity. He gives a very thorough review of the literature of the subject.

—The appropriation for the U. S. Geological Survey was much reduced by the last Congress. Nearly forty members of the present force will be asked to resign. Washington dispatches to the newspaper press

state that this list includes three $4000 geologists, one $3000 geologist, two $2400 geologists, two $2000 geologists, one $2000 chemist, two $2500 geographers, one $2000 topographer and one $3000 officer, classed as a general assistant. These are dropped altogether, as is also vertebrate paleontology. Twenty-six other employees will also have to submit to a reduction of pay. Major Powell, Chief Director of the Bureau, says that six of the scientists thus summarily disposed of have volunteered to stay and complete the work they are employed upon without present compensation, and seventeen others have already secured professorships in various colleges and other educational institutions. He adds that the reduction of force will compel him to drop some branches of the work upon which he has been engaged, but he believes he will be able to struggle along until Congress reassembles in December.

—The northwestern division of the Geological Survey of Texas is under charge of Mr. W. F. Cummins. Mr. Cummins' party has explored during the present season the formations which appear along the eastern border of the Staked Plains, and is at present examining the Permian formation along the waters of the Red River.

MINERALOGY AND PETROGRAPHY.[1]

Thermometamorphism.—A very brief but extremely interesting review of the effects of thermometamorphism in the acid and basic lavas in contact with granite and granophyre in the Lake District, Eng., is given by Harker.[2] The altered zone surrounding the latter rocks is about ¾ of a mile wide. On its outer periphery only the secondary constituents of the basic lavas have been affected by the contact action. This leads the author to the statement that the substances most susceptible to thermal agency are those formed under ordinary meteoric conditions, minerals of direct igneous origin being more refractory. In the rocks under discussion but little change in chemical composition has taken place as a consequence of their metamorphism, except that there is a loss of water and a gain in boron quite near the contact. The mineralogical changes noted are the production of biotite from the chloritic decomposition products of pyroxene and the formation of clear feldspar from the original turbid mineral. In addition to these, quartz, green hornblende, actinolite, tremolite, augite, sphene, rutile, magnetite and pyrite have also resulted from the metamorphic processes. The characteristic contact minerals of sedimentary rocks, cyanite, andalusite and garnet are practically absent. Their abundant presence in sedimentary rocks is thought to be due to the fact that these contain but a small proportion of alkalies, as a result of the long continued chemical degradation to which they have been subjected, and that since feldspar, which the author regards as a characteristic contact mineral, could not form, only aluminous new products are possible. The careful study of the altered rocks indicates that there was very little interchange of substance between different portions of the original rock, except between those parts that were immediately adjacent. The preservation of minute structures, such as fluxion lines and spherulitic aggregates, point to this conclusion. In the case of the acid lavas the material very near the metamorphosing mass consists principally of a fine-grained aggregate of feldspar and quartz. Aluminous and ferruginous compounds were absent from the original lava; they are likewise absent from its altered phases.

[1]Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2]Bull. Geol. Soc. Amer., Vol. iii, 1892, p. 16.

Cellular Epidote in Granite.—Three granite sections from Wrangell Island, Alaska, the Pelly River in the Yukon District, and from the Stikine River, in the Coast Range of British Columbia, are described by Adams[3] as exhibiting several interesting peculiarities. All possess large quantities of epidote, which has a rudely outlined crystal form. In the specimen from the first mentioned locality the epidote is intergrown with allanite, with the latter on the interior. The most peculiar feature in connection with the epidote is its cellular structure, it being merely a skeleton of this substance enclosing small, elbow-shaped areas of quartz, feldspar, etc. Calcite and muscovite grains were noted with the same structure. In the case of the mica the inclusions occupy such a large portion of the area enclosed within the outline of the mineral that the muscovite appears as an assemblage of detached fragments, optically continuous with one another. Upon discussing the origin of the cellular minerals the author is compelled to the conclusion that they have all been formed since the consolidation of the rocks in which they occur. Since these all show evidence of having undergone slight crushing, it may be that the growth of the minerals is dependent somehow upon the reactions set up during the crushing. As all the constituents in these granites are fresh, the conclusion that the calcite, muscovite and epidote are secondary is an interesting one.

Petrographical Notes.—In an article descriptive of Chilean ore deposits Möricke[4] gives a few petrographical notes on a hornblende-biotite granite, a tourmaline granite, a quartz diorite, a quartz porphyry, and two other rocks of special interest. One is a quartz tourmaline rock in which a sort of groundmass of the former mineral encloses small idiomorphic crystals of the tourmaline. It is presumably an eruptive. The other is a perlitic pitchstone from Guanaco, with large phenocrysts of plagioclase and sanidine and a few flakes of biotite. Its unique feature is the possession of gold in skeleton crystals scattered through the glassy matrix, enclosed in the spherulites and included in the fresh feldspar.——Masses of an azure blue saccharoidal[5] rock occur imbedded in a granular serpentine at a point on the Gila River, 40 miles west of Silver City, N. M. In the thin section these masses are found to be composed of a granular, colorless

[3]Canadian Rec. of Sci., Sept., 1891, p. 344.

[4]Min. u. Petrog., Mitth. xii, p. 195.

[5]Merrill and Packard. Amer. Jour. Sci., April, 1892, p. 279.

pyroxene intermingled with calcite, with the pyroxene more or less altered into serpentine. A fragment of the rock free from calcite and serpentine gave: $SiO_2 = 54.30$; $MgO = 18.33$; $FeO = 1.11$; $CaO = 25.00$, a composition corresponding to $Ca\,Mg\,(SiO_3)_2$. The blue color is supposed to be due to the ferrous iron present in the pyroxene.

Two New Rocks.—Boninite is a bronzite limburgite from Peel Island, one of the Bonine group, near Japan. It is described by Petersen[6] and Kikuchi[7] as consisting of phenocrysts of olivine, bronzite and a few augites imbedded in a glass full of crystallites, some of which are sanidine. The rock is closely related to sanukite.[8] Mijakite from Mijakeshima is an andesite with a reddish brown pyroxene, supposed to be triclinic, feldspar and glass, forming a groundmass in which are porphyritic crystals of bytownite, a little augite, hypersthene and biotite. The composition is:

SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	Loss	Total.
50.87	21.98	5.85	5.09	1.45	1.38	9.12	2.85	22	.43	= 99.24

Optical Anomalies.—In a prize volume[9] issued by the Fürstlich Jablonowski Society of Leipzig, Brauns discusses critically and in great detail the various theories proposed in explanation of optical anomalies and gives a resumè of all the work done on individual minerals exhibiting the phenomena. About seventy substances in which anomalies have been discovered are treated in the second part of the volume, while in the first part the space is devoted to the historical and critical discussion of the theories. The anomalous bodies are divided into five groups according as the cause of their peculiarities is differently orientated lamellæ; dimorphous enantiotropism of their substance, strain, isomorphous mixture or loss of water. In an appendix are grouped those minerals the cause of whose anomalies is unknown.——Pyrenaite, the black garnet occurring in a black limestone at the Pic d'Eres Lids, Pyrenees, show such regular anomalies that Mallard[10] is enabled to determine the optical constants of the sub-

[6]Jahrb. Hamburg. wissensch. Anst. viii, 1891, p. 1.

[7]Jour. Coll. of Sci., Imp. Univ. Japan, iii, 1889, p. 67. Ref. Neues Jahrb. f. Min., etc., 1892, i, pp. 311 and 313.

[8]Amer. Naturalist, 1891, p. 368.

[9]Die Optischen Anomalien der Krystalle. Leipzig, S. Hirzel, 1891. Pl. 6, pp. 10 and 370.

[10]Bull. Soc. Franç. d. Min., xiv, p. 293.

stance whose six orthorhombic pyramids build up the perfect dodecahedral crystals. Its mean index of refraction is 1.74 and its optical angle $2V = 56° 5'$. The author regards his observations as settling the question as to the cause of optical anomalies in garnet in favor of his own theory and in opposition to the theories of Klein and of Brauns, the former of whom regards them as due to the dimorphism of the garnet molecule and the tension resulting from its attempt to pass to a more stable form than that in which it crystallized, and the latter as due to isomorphous mixtures.

Examination of thin sections of beryl crystals from the Ilmengebirge in the Urals leads Karnojitzky[11] to the belief that the anomalies discoverable therein are dependent directly upon the limiting faces of the crystals. When these differ the character of the internal structure differs, as is also often true in the case of garnet. An optically anomalous beryl crystal consists of several elemental individuals, the number and position of which correspond closely with the number and positions of the limiting planes of the crystals. The positions of the individuals preclude the notion of twinning. The author thinks the anomalies due to the isomorphous mixture of the beryl substance with some other, probably tourmaline.——In a section of dioptase cut parallel to the base the same investigator[12] found uniaxial areas distributed among the normal biaxial areas in such a way as to convince him that the interior structure of the mineral is determined to some extent by its exterior form, as in the case of the beryl.

Mineralogical News.—Genth and Penfield[13] have obtained *hübnerite* crystals from two localities near Silverton, Col., from White Oaks, N. M., and from Nye Co., Nev. Those from the North Star Mine, near Silverton, were doubly terminated, so that by their measurement the axial ratio, .8362 : 1 : .8668, was determined. Cleavage sections parallel to $\infty P\breve{\infty}$ extinguish at about 17° from c in the obtuse β, which direction is the axis of least elasticity. Pleochroism is marked, being green parallel to C and yellowish brown parallel to B. Density is 6.713 and composition $WO_3 = 74.75$; $FeO = 2.91$; $MnO = 21.93$; $CaO = .11$; $MgO =$ tr. *Bismuthite* from the phenacite locality of Mount Antero, Col., and *hessite* from the Refugio Mine, Jolisco, Mex., are also briefly described by the same authors. They were, however, too impure to yield good analytical results. A *natrolite*

[11]Zeits. f. Kryst., 1891, xix, p. 209.

[12]Ib., 1891, xix, p. 593.

[13]Amer. Jour. Sci., March, 1892, p. 184.

associated with eudialite, etc., at Magnet Cove, Ark., is in large colorless crystals whose analysis gave: $SiO_2 = 47.97$; $Al_2O_3 = 26.51$; $Na_2O = 15.98$; $H_2O = 9.81$.

Yeates and Ayres[14] have come into the possession of sufficient quantities of *plattnerite* to enable them to describe it in some detail. The mineral is associated with limonite and white pyromorphite at the "You Like" lode, near Mullan, Idaho. The pyromorphite is in veins cutting nodules of the plattnerite and in little crystals imbedded in them. The color of the lead oxide is iron black. Its streak is chestnut-brown, its hardness 5.5 and density 8.56. An analysis showed the following composition: Pb = 83.20; Ag = tr.; Cu = .14; Fe Al = 1.20; O = 12.93; Ins. = .82, besides Ca and Mg. Upon breaking open some of the nodules little cavities were found in it, whose walls were covered by druses of tiny crystals. These plattnerite crystals are tetragonal and isomorphous with the members of the rutile group. $a : c = 1 : .67643$. They are prismatic with $\infty P\infty$, $3P\infty$ and sometimes oP and $\frac{3}{2}P$.

In another contribution to the discussion of the constitution of micas and chlorites Clarke and Schneider[15] communicate results of analyses of *waluewite, clinochlor* and *leuchtenbergite* from Slatoust, of diallage *serpentine* from Syssert, and of white *mica* from Miask, in the Urals. One of the conclusions based upon the action of the chlorites toward reagents is to the effect that their composition cannot be explained in terms of the Tschermak theory.

At Placerville, Eldorado Co., Cal., is a vein of quartz cutting quartzite. The vein is much decomposed and contains pockets of red earth in which are numbers of *quartz*[16] crystals, some of immense size. Many bear inclusions of chlorite arranged in zones marking successive stages of growth, and others contain hollows that are moulds of groups of some rhombohedral mineral, probably siderite. *Brookite* and *octahedrite* are also found in these pockets, sometimes loose in the clay, sometimes implanted upon the quartz or included within it. In the same article there is described an immense *monazite* crystal from Perm, Russia, and enormous rubies from Moguk, near Mandalay, Burma.

The *bournonite* of Nagybanya, in Hungary, is associated with zinc, lead and other sulphides, siderite and quartz. According to A. Schmidt[17] two types of the bournonite occur, the prismatic and the

[14]Ib., 1892, May, p. 407.

[15]Ib., 1892, p. 378.

[16]Ib., Feb., 1892, p. 329.

[17]Zeits. f. Kryst., xx, p. 152.

tabular, both of which are rich in forms. Two new planes $\frac{5}{3}P\bar{\infty}$ and $2P\breve{\infty}$ raise the number of forms known to occur in the species to 75.

In the carbonaceous mica schists near the contact with granite in the Müglitzthal, S. E. of Dresden, Beck[18] has discovered small crystals of *brookite.* The original rock from which the schists were made contained rutile needles. These afforded the material for the brookites, which are found lying with their flat sides parallel to the cleavage planes of the schists.

The striations parallel with and perpendicular to the octahedral edges of the *magnetite* crystals from Mineville, N. Y., are ascribed by Kemp[19] to etching agents. The striations parallel to the edges are usually referred to twinning, but in the present case it is probable that Kemp's explanation is the correct one, for when unstriated crystals are subjected to the influence of HCl and H_2SO_4 they become covered with striations like those occurring in nature.

A lot of very pure *cordierite* from coarse veins cutting gneiss at Guilford, Ct., has been analyzed by Farrington,[20] who finds in it:

SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	H_2O
49.44	32.97	.35	5.11	.32	10.39	1.65

corresponding to H_2O, 4(Mg Fe)O, 4 Al_2O_3, 10 SiO_2.

Treadwell[21] has made a new analysis of *milarite* that yielded him:

SiO_2	Al_2O_3	CaO	K_2O	Na_2O	H_2O	MgO
72.79	10.12	11.32	4.32	.26	1.19	tr.

This corresponds to R_2O, 2 CaO, Al_2O_3, 12 SiO_2.

Scalenohedral and prismatic crystals of *calcite* from Niederrabenstein, in Saxony, are described by Beckenkamp.[22] The prismatic ones are tetartohedral and hemimorphic.

Miscellaneous.—Dunnington,[23] after careful quantitative analyses of seventy-two soils from various localities as widely separated as the Sandwich Islands and Palestine, comes to the conclusion that all

[18]Neues Jahrb. f. Min., etc., 1892, i, p. 159.

[19]Zeits. f. Kryst., xix, p. 193.

[20]Amer. Jour. Sci., Jan., 1892, p. 13.

[21]Neues Jahrb. f. Min., etc., 1892, i, p. 167.

[22]Zeits. f. Kryst., xx, p. 163.

[23]Amer. Jour. Sci., Dec., 1891, p. 491.

contain titanium, which of course must necessarily exist as widely spread in the rocks from which the soils were made.

Small crystals of *melilite* have been detected by Bödländer[24] in a mass formed by the melting of Portland cement in an oven with a lining containing 63%–88% of SiO_2. The raw materials used as the charge consisted of a mixture of magnesia, limestone and clay. The crystals were imbedded in a mass of olivine(?), magnetite, mica and apatite. The crystals were found to be optically positive and to have the composition :

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O
37.96	9.46	2.93	34.75	12.77	1.53	.64

Becke[25] gives brief but very definite directions as to the use of his method of distinguishing between quartz, orthoclase and plagioclase by etching with hydrofluoric acid and staining their etched surfaces.

Schrauf[26] describes a method of combining microscope and reflection goniometer in such a way that minute crystals may easily be studied and measured.

[24] Neues Jahrb. f. Min., etc., 1892, i, p. 53.

[25] Min. u. Petrog., Mitth. xii, p. 257.

[26] Zeits. f. Kryst., xx, p. 90.

BOTANY.

Botany at the Rochester Meeting.—There was so much Botany at the Rochester meeting of the American Association for the Advancement of Science that the space here given will scarcely more than admit of a catalogue of the papers and their authors. The botanical work was divided into that of the section and of the club. Section F at the Rochester meeting included all papers which came under the broad head of biology, and of these the total was no less than fifty-seven, a large share being upon botany. At the Washington meeting there was a proposition made to divide the section into two, namely one for zoology and one for botany. After a thorough canvass of the subject in the Section the council finally voted unanimously to recommend such a division and it was made by the Association. The new Section of Botany takes the letter G, and hereafter botanists will be by themselves in Section G.

The first two papers in the Section were by Dr. N. L. Britton upon—"Notes on *Ranunculus repens* and its Eastern North American Allies" and "Notes on a Monograph of the North American species of Lespedeza". A large number of specimens were shown which enforced the position taken by the author. Mr. W. W. Rowlee instructor in Botany at Cornell University presented a paper upon "The Root System of *Mikania scandens,* in which the strange development of a mass of fibrous roots was brought out. Specimens were shown of the bog water masses of roots. Prof. L. M. Underwood gave a "Preliminary comparison of the Hepatic Flora of boreal and sub-boreal regions" showing many points of difference.

Dr. E. F. Smith gave two papers bearing upon his long prosecuted labors namely—"On the value of wood ashes in the treatment of peach yellows" and "On the value of superphosphates and muriate of potash in the treatment of peach yellows". The genuine "yellows" is not cured by the use of plant food and is a specific disease. When asked for the cause of the trouble Dr. Smith replied that he wished he knew.

Prof. Macloskie presented "Notes on Maize" and advocated this plant as worthy of becoming the "National flower"—"Spikes of wheat bearing abnormal spikelets" was a paper by Dr. Beal, as also the following—"A study of the relative length of the sheaths and internodes of grasses for the purpose of determining to what extent

this is a reliable specific character". Both papers were fully illustrated by specimens and wall charts.

Mr. Rowlee's second communication was "Adaptation of seeds to facilitate germination" in which he showed that many structures apparently for dissemination were for holding water or otherwise aiding in germination. Dr. H. L. Russell in "Bacteriological investigations of marine waters and the sea floor" showed that microörganisms exist in great numbers in the deep sea and that such forms offer many advantages for the study of physiological problems. Mr. T. V. Coville gave a "Sketch of the flora of Death Valley, California," where he has spent some time in the study of the strange forms. "How the application of hot water to seeds increases the yield" was shown by Dr. J. C. Arthur. The hot bath stimulates the development of a ferment and this quickens the seed to greater vitality and growth. Prof. L. H. Bailey "On the supposed correlation of quality in fruits—a study in evolution", showed that cultivated fruits are an improvement in flavor as well as in size over the wild forms from which they came.

A second paper by Dr. Russell was upon "Non-parasitic bacteria in vegetable tissue". There was some discussion following it, upon the method of penetration of organisms through vegetable tissues, the continuity of protoplasm offering the best explanation.

Prof. Kellerman's two papers were "Notes on yellow pitch-pine—*Pinus rigida* Mill., var. *lutea* Kell., n. v." and "Germination at intervals of seed treated with fungicides" the latter showing some striking results. In his study of "The fertilization of pear flowers". Mr. M. B. Waite found that the barrenness of orchards in some cases can be explained by the impotency of self-pollination.

Mr. T. B. Maxwell presented the results of "A comparative study of the roots of Ranuculaceæ." In "Adaptation of plants to external environment" Prof. W. P. Wilson, by means of a large number of lantern slides showed the influence of heat, light, high altitude, etc., upon the position of leaves upon various species of plants. Prof. S. A. Beach presented "Notes on self-pollination of the grape" and showed that some sorts need foreign pollen. "The comparative influence of odor and color in attracting insects" was brought out by Mr. G. B. Sudworth. "Notes on *Daucus carota*" were given by Prof. C. W Hargitt. A second paper by Mr. Coville, "Geographic relationship of the flora of the high Sierra Nevada, California," gave further results of the author's studies in the far west. Rev. W. M. Beauchamp presented "Variation in native ferns," followed by D. G. Fairchild on "Live-forever eradicated by a fungous disease," a rare instance of a

weed being successfully exterminated by a parasite. In the absence of the author, Dr. Vasey's paper upon "Otto Kuntze's changes in the nomenclature of North American grasses" was read only by title. A combination paper by Messrs Fernow and Sudworth upon "Revised nomenclature of the arborescent flora of the United States" was passed with a few remarks by Prof. Fernow, stating that the subject matter had been disposed of in the Botanical Club. A third paper by Mr. Coville was upon "Characteristics and adaptations of desert vegetation." In his absence, Mr. F. Roth's paper "Shrinkage of wood as observed under the microscope" was passed, as likewise two sent by Prof. Pammel upon "*Peziza sclerotium*" and "Temperature, and some of its relations to plant life." The "Pleospora of *Tropæolum majus*," "Secondary spores of anthracnoses" and "A bacterium of Phaseolus" were read by B. D. Halstead. Prof. Meehan's paper, "The significance of cleistogamy," in the author's absence was read by title, thus closing the schedule of botanical papers of Section F, with a total of thirty-eight papers.

The Botanical Club held many meetings and they were largely attended. In the absence of the president, Prof. Spalding, Dr. H. H. Rusby was elected to the chair. Mr. Coville presented a paper upon "Range, locality, station, and habitat." After considerable discussion the conclusion seemed to be that "range" was the region over which a species naturally grows; "locality," the geographic position of the species; "station," the spot where the species occurs, and "habitat," the kind of place where the individual specimens grow.

Thomas Morong gave a paper upon "Travels in Paraguay, and its flora." Dr. Rusby, also an exploring botanist, remarked upon the trials and dangers of such work. Prof. Underwood showed "A variety of *Polypodium vulgare* L., new to America."

The paper by Mr. Maxwell on "Symbiotic growths in the roots of Ranunculaceæ" brought out many questions, particularly from the mycologists. "Some rare and interesting fungi from Florida" were shown by Mr. Swingle and fully discussed.

Mr. Morong's second paper "Observations upon certain species of Asclepiadaceæ as insect traps" was discussed by Dr. Beal and others, after which Dr. Vasey gave a full account of the work of the Botanical division of the U. S. Department of Agriculture.

Dr. Arthur spoke next of the Botanical Congress at the World's Columbian Exposition, and the subject was considered at length and a committee appointed to confer with officers of the new section of botany in the matter. Mr. O. F. Cook who has recently returned from

Africa gave the next paper upon "General notes on the cryptogamic flora of Liberia."

A large portion of the sessions was taken up with the consideration of the important subject of nomenclature. A committee was appointed early in the meeting and its report fully considered. While space will not allow the whole of the conclusions arrived at, the following are given as showing the thoroughness of the work: "Publication of a genus consists only (1) in the distribution of a printed description of the genus named; (2) in the publication of the name of the genus and the citation of one or more previously published species as examples or types of the genus with or without a diagnosis." The "publication of a species consists only (1) in the distribution of a printed description of the species named; (2) in the publishing of a binomial, with reference to a previously published species as a type."

The following are some of the papers presented at the Club: "Some of the rare mosses of White Top and vicinity, recently collected on a trip to Southwestern Virginia, with specimens," by Mrs. E. G. Britton; "Galvanotropism," by Dr. Arthur; "Anatomy as a special department of Botany," by Miss Gregory; "A botanical terminology," by A. A. Crozier; "Notes on some pear and apple diseases," by B. M. Waite; "Modifications of the tomato fruit resulting from seed selection," E. S. Goff; "Cultivated species of Bassica," by L. H. Bailey; "Notes on the mountain flora of Northern Alabama," by Dr. Mohr; "Notes on the distribution of plants in Florida," by P. H. Rolfs; "North American Cacti," by Prest. Coulter; "On the proposed handbook of mosses of Eastern America, with specimens," by Mrs. Britton; "Weeds and weed roots," by B. D. Halsted; "The re-discovery of *Juncus cooperi*," by F. V. Coville; "Some general questions in the classification of Myxomycetes," by O. F. Cook; "The North American Amelanchiers," by N. L. Britton; "Observations on the North American species of Orchidaceæ and their nomenclature," by Thos. Morong; "A new form of root cage," by J. C. Arthur; "The botanical garden movement in New York," by N. L. Britton; "A few additions to the hepatic flora of the Manual region," by L. M. Underwood; "Notes upon a revision of the North American Naidaceæ," by Thos. Morong; "On the genus Campylopus in North America," by Mrs. Britton; "Some noteworthy features of the flora of West Virginia," by Dr. Millspaugh; "Notes on a recent outbreak of peach yellows near Ann Arbor, Mich.," by A. A. Crozier; "Some observations on *Epigea repens*," by Dr. Wilson; "Notes on some species of Cratægus," by Dr. Britton; "Observations on the ripening of the seeds of

Cuphea," by Mrs. Wolcott; "On the genus Ditrichium in North America, with one western species, and corrections for two eastern species," by Mrs. Britton; "Notes on terminology," by Thos. Holm; "Notes on some fungi common during the season of 1892, at Ames, Ia.," by L. H. Pammel; "Notes on some Kansas weeds," by A. S. Hitchcock; "Notes on the flora of Block Island," by W. W. Bailey; "Notes on the distribution of a few plants," by L. H. Pammel also "Phænological notes for 1892," by Prof. Pammel. This is a total of forty-one papers for the club. These with the thirty-eight named as on the programme of Section F give a grand total of seventy-nine papers presented at Rochester by the botanists. Many others not here mentioned were given before the Microscopical Society and the Society for the Promotion of Agricultural Science, so that it is safe to state that the number of botanical titles at the several conventions held at Rochester during ten days was in the neighborhood of, if it did not exceed, one hundred.

It was evidently the botanist's meeting, and with a new section established for them in the A. A. A. S., the workers upon plants, in all the various departments, may well feel encouraged to go forward to greater triumphs in the near future.—Byron D. Halsted.

Citation of Authors of Genera and Species.[1]—In order to obtain stability of nomenclature it is necessary to provide that the name of a plant, the specific name, cannot be changed through caprice or whim. Nor can it be changed through ignorance, providing the mistake through which the name was made has been discovered. The refusal to correct mistakes and the disinclination to do thorough bibliographical work before publishing a new specific name is the cause of most confusion in botanical nomenclature. Hence has arisen the so-called international law or law of priority which provides that the earliest published specific name of any plant must stand, providing that the name is not antedated by some other similar name applied to a plant belonging in the same genus. Many botanists do not admit the validity of this principle except in the case of species which they may have themselves named and published. With reference to others they are accustomed to insist that "customs," "long established habit" and a conservative condition must be maintained. This is to save the difficulty of having to revise their own systems of nomenclature, and serves in many cases to cover inaccuracies or hastiness. With this

[1]From "The Metaspermæ of the Minnesota Valley," in Report of the Geological and Natural History Survey of Minnesota (1892).

conservative position, the unthinking and unbotanical are always distinctly satisfied and are accustomed to declare that botanical nomenclature is purely a "practical matter" and should be taken out of the hands of the botanists altogether and turned over to some unprofessional commission for settlement. Objections of this sort are natural, for the changing of names in our accustomed department of science is always a confusing matter. Such criticism is, however, unthinking and unbotanical because it fails to recognize that the whole difficulty has originated on account of just such conditions as are extolled and recommended for perpetuation. The only way to obtain a stable nomenclature is by rigidly enforcing the law of priority with reference to specific names. All instability finds its well spring in the disregard of this law, and stability under our present general system of nomenclature can only be obtained by strict adherence to the oldest available specific name, by whomever or wherever it may have been published.

The cause of the present upheaval in plant nomenclature, signalized but not at all initiated, by such a book as that of Kuntze, is very easy to discover. Never so much as to-day has botany become world-wide. The multiplicity of periodicals, the facilities for exchange and correspondence between different countries, expeditions, congresses, communications, the development of new centers of activity in all parts of the globe, all conspire to make insularity of nomenclature impracticable, except for those who do not care to be within the pale of modern conditions. It was a matter of less importance fifty years ago, if the name *Potamogeton pauciflorus* was given to one plant in France, by Lamarck, and to quite a different plant in America, by Pursh. There was less danger of confusion, for French botanists and American botanists were not then so distinctly interested in each other's field. The international character of science was recognized long ago in the adoption of an international language—Latin—in which oriental and occidental investigators can communicate, whatever their native dialect. The law of priority simply carries this recognition farther, and provides that in the department of nomenclature Latin shall be used in the same sense in all countries.

In America the rightful implication of the law of priority has been ably expounded by Britton and Greene, seconded by many others. Under their leadership most of the younger school of botanists have determined to enlist, but the older men whose life works have been largely accomplished under the older and insular interpretation, the provincial dispensation, as it may be named, have in most cases failed to withdraw from the position of their youth—the "position of nam-

ing-plants-as-one-pleases"—and their publications are in consequence marred by the illegal nomenclature. Manuals and handy reference floras, most local lists and many monographs have perpetuated the faulty and insular methods and it is but very recently that a concerted attempt is being made to establish this department of botanical work upon the only sure foundation possible without a complete withdrawal from the existant system.—CONWAY MACMILLAN.

Rules of Botanical Nomenclature.—It is with great pleasure that we print the following rules of botanical nomenclature, as adopted by the Botanical Club of the American Association for the Advance- of Science, at a meeting held in Rochester, August 19th, 1892. We trust that they will be generally accepted by American botanists.

Resolved: That the Paris code of 1867 be adopted, except where it conflicts with the following:

I. THE LAW OF PRIORITY.

Priority of publication is to be regarded as the fundamental principle of botanical nomenclature.

II. BEGINNING OF BOTANICAL NOMENCLATURE.

The botanical nomenclature of both genera and species is to begin with the publication of the first edition of Linnæus "Species Plantarum," in 1753.

III. STABILITY OF SPECIFIC NAMES.

In the transfer of a species to a genus other than the one under which it was first published, the original specific name is to be retained, unless it is identical with the generic name or with a specific name previously used in that genus.

IV. HOMONYMS.

The publication of a generic name or a binomial, invalidates the use of the same name for any subsequently published genus or species respectively.

V. PUBLICATION OF GENERA.

Publication of a genus consists only (1) in the distribution of a printed description of the genus named; (2) in the publication of the name of the genus, and the citation of one or more previously published species as examples or types of the genus, with or without a diagnosis.

VI. Publication of Species.

Publication of a species consists only (1) in the distribution of a printed description of the species named; (2) in the publishing of a binomial, with reference to a previously published species as a type.

VII. Similar Generic Names.

Similar generic names are not to be rejected on account of slight differences, except in the spelling of the same word; for example, *Apios* and *Apium* are to be retained, but of *Epidendrum* and *Epidendron*, *Asterocarpus* and *Astrocarpus*, the latter is to be rejected.

VIII. Citation of Authorities.

In the case of a species which has been transferred from one genus, to another the original author must always be cited in parenthesis, followed by the author of the new binomial.

ZOOLOGY.

Fortuitous Variation.—In a paper just published, read before the Biological Society of Washington, on "Some Interrelations of Plants and Insects," in which Professor C. V. Riley deals with the subjects of Yucca pollination and fig caprification, he generalizes from the facts recorded as follows:

"The peculiarities which I have endeavored to present to you are full of suggestion, particularly for those who are in the habit of looking beyond the mere facts of observation in endeavors to find some rational explanation of them; who, in other words, see in everything they observe significances and harmonies not generally understood. The facts indicate clearly, it seems to me, how the peculiar structures of the female Pronuba have been evolved by gradual adaptation to the particular functions which we now find her performing. With the growing adaptation to Pronuba's help, the Yucca flower has lost, to a great extent, the activity of its septal glands; yet coincident with it we find an increase in the secreting power of the stigma. This increase of the stigmatic fluid has undoubtedly had much to do with originally attracting the moth thereto, while the pollenizing instinct doubtless became more and more fixed in proportion as the insect lost the power or desire of feeding. With the mind's eye I can look back into the past and picture the gradual steps by which the Prodoxids to which I have alluded have differentiated along lines which have resulted in

their present characteristics. On the one side I see variations which have become sufficiently fixed to be considered specific; yet which can have no especial bearing on the life necessities of the species, but are a consequence rather of that universal tendency to variation with which every student of Nature becomes profoundly impressed. Thus the wing-markings vary from a darker general coloring, as in *Prodoxus œnescens*, to a more uniform intermixture of the black scales among the white, as in *cinereus*, or a sparser intermixture thereof, as in *pulverulentus*. The disposition of the black scales is in spots or bands, whether transverse or longitudinal, as in *marginatus*, *reticulatus*, *Y-inversus*, etc. These are fortuitous variations, for I can-cannot believe that the disposition of these marks where, as in these cases, they take every form that is conceivable, can be of any benefit to the species, any more than the mere variation in the number of lobes in the leaves of different oaks growing under like conditions can be of any particular benefit to the species, however useful to us in classification.

"In my address before the Section of Biology of the American Association for the Advancement of Science, at Cleveland, in 1888, I have discussed the various forms and causes of variation, and especially the limitations of natural selection, stating expressly that this last "deals only with variations useful to the organism in its struggle for existence, and can exert no power in fixing the endless number of what, from present knowledge, we are obliged to consider fortuitous characters," and I have long recognized, from my studies of insect life, the existence of these fortuitous variations. The subject has since been very well elaborated by Professor Ward in his communication to the Society (December 15, 1888) on "Fortuitous variation as illustrated by the genus Eupatorium" and in his Annual Address (January 24, 1891) on "Neo-Darwinism and Neo-Lamarckism," and the Prodoxidæ furnish an excellent illustration of this fortuitous variation. Yet at the same time that we note this chance variation, as exemplified in a number of the species of Prodoxus, which are mere ravagers or despoilers and have not been brought into any special or mutual relations with the plant, we have, on the other hand, in *Pronuba yuccasella*, correlated with the other striking structural modifications which have brought it into such special relations with the plant, an elimination of all maculation or markings upon the primaries, and a purely white coloring so fixed that it shows absolutely no variation over half the continent. The structural variation has been necessary—a consequence of effort, environment,

and natural selection. The color variation, on the contrary, has not been absolutely necessary, yet has nevertheless gone on in lines which, tending to give greater protective resemblance to the flower, have in the long run proved to be, perhaps, the most advantageous. I thus recognize three distinct lines of variation as exemplified in these Prodoxidæ, and what is true of them is, I believe, true of all alliances of organisms. The first and most important is structural and generic; it is absolutely essential and is preserved in its perfection by the elimination, through natural selection, of all forms departing from it. The second is merely coincident, not essential, but nevertheless along lines that are of secondary advantage. The third is purely fortuitous, affects superficial features in the main, is unessential (a consequence of the inherent tendency of all things to vary), and takes place along all lines and in all directions where there is no counteracting resistance."

Structure of Calcareous Sponges.—Minchin[1] finds in a calcareous sponge, which he identifies as *Leucosolenia coriacea*, a peculiar fenestrated membrane crossing the oscular openings. This "sieve membrane" is composed of two layers of cells and crosses the tube just above the limits of the flagellate entoderm. Minchin, with a question, identifies the two layers as ectoderm and entoderm, and thus is it probable that the membrane is formed by the gastral cavity breaking through to the exterior at several points during development. Interesting comparisons are made with the sieve plates of several Hexactinellids. In a second paper[2] the same author concludes from a study of Naples material that *L. clathrus* does not have the oscula permanently closed, but that these openings are capable of occlusion by means of a sphincter of ectoderm. Further that Haeckel's so-called species, *Ascetta labyrinthus*, *A. mœandrina*, *A. clathrina* and *A. mirabilis* are all different stages of contraction of the one species, *Leucosolenia clathrus*.

On Echinorhynchus.—Two extensive works on the embryology of *Echinorhynchus* have recently appeared in Germany, one by Kaiser, which is not yet completed, the other by Hamann.

The following is a brief summary of Hamann's article. (Die Nemathelminthen, Jena, 1891, 119 pages, 10 plates.)

The first stages can be studied to the best advantage on *E. acus*. The extrusion of the pole-bodies and the division into 2 and 4 cells

[1]Q. J. M. S., xxxiii, 251, 1891.

[2]*l. c.*, p. 490, 1892.

occur while the egg is still in the "egg-ball." It is not yet determined at what time the fertilization of the ovum takes place. In the case of *E. acus* the gastrula (larva with 6–8 hooks) goes through certain changes, in the body of the mother, which in other species are delayed until the parasite arrives in an intermediate host. According to Hamann the nuclei of the ectoblast unite to form very large nuclei, the ectoblast being a syncytium.

Ectoderm:—A syncytium with large nuclear bodies which are amoeboid and give rise by *direct division* to the nuclei of the skin; the fibres in the skin are looked upon as elastic. The species *E. clavæceps* is especially interesting: in this case the skin of the adult remains a syncytium with large nuclear bodies; author looks upon this as a case of paedogenesis. In other species the ectoderm separates into two layers: an outer layer with nuclei and elastic fibres, an inner layer in which the lacunes are formed. The lacunes of the skin and lemnisci form at the same time that the giant nuclei of the ectoderm divide into the skin-nuclei. The lemnisci arise as two lateral papillæ of ectodermal origin; these project into the body cavity; they are at first solid but when they have reached their full length a number of light colored spots became visible in their substance; these spots grow more numerous, become connected and form the canal-system. In *E. clavæceps* the lemnisci retain their larval character, being round with central canal and two very large nuclei. In other species the lemnisci are more highly developed; the canal-system is branched and numerous nuclei are present. The canal-system of the lemnisci, neck and rostellum unite in the circular canal and, according to Hamann (in agreement with Schneider but in opposition to Leuckart's view), are entirely separated from the lacunes of the rest of the body. The lemnisci are compared with the ampullæ of the echinoderms. Hamann supposes them to aid in stretching the rostellum and to act as a reservoir for the liquid when the rostellum is retracted.

Entoderm:—In the early stages the entoderm is a solid mass, but as the parasite develops, an outer layer of cells separates from the central mass and forms an epithelial lining membrane for the body-cavity (coelom); the remaining cells give rise to the genital organs and the ligament. On the outer layer peripheral circular muscle fibrillæ form in each cell, thus giving rise to epithelial-muscle cells of entodermal origin. Some of these cells leave their position in the epithelium and wander to its median surface where they assume a spindle shape and give rise to the longitudinal muscles, which anastomose.

The anlage of the proboscis forms very early; two cells differentiate at one pole of the entoderm, behind this the cells gradually coalesce. The sheath is also entodermal. The proboscis is formed *invaginated* inside the sheath; the cause of exvagination is to be sought for in the growth of the animal in length. (Reviewer does not understand author's argument in this case.) Before exvagination the rostellum is solid; what becomes of the centre core is somewhat uncertain. The hooks are also of entodermal origin; further, the nervous system, which arises at about the same time with the rostellum, and consists of a double ganglion at the base of the rostellum, two lateral and one median anterior nerves and two lateral posterior nerves. The latter connect with a double ganglion on the bursa of the male. The ganglion cells were uni-polar.

Hamann's results differ very greatly, in some particulars, from those arrived at by Kaiser. Kaiser's magnificent monograph will be reviewed in a later issue of THE NATURALIST.—C. W. S.

Onchnesoma.—Shipley has recently studied[3] the anatomy of *Onchnesoma steenstrupii*, the smallest species of this boreal genus of Sipunculids. In correspondence with its small size (length 3 mm.) it is much simplified. It has no tentacles, no vascular system, a single retractor muscle, a single nephridium, and a not-bilobed brain. On account of the lack of tentacles this Sipunculid, at least, does not breathe by these organs, and Shipley is inclined to regard the intestine as the chief respiratory organ here. He is farther inclined to think that the chief function of the tentacles, when present, is to create currents bringing food to the mouth, and that the chief use of the vascular system is to extend the tentacles.

The Hæmal Region of Echinoderms.—This portion of the echinoderm structure has always been a terra incognita. In the course of an interesting article on "Wandering Cells in Echinoderms"[4] (dealing with the processes of excretion throughout the animal kingdom) Mr. H. E. Durham says: "The following method of regarding the relations of the water tube, dorsal organ, axial perihæmal sinus, and the madeporic or water pores has, I believe, never been formulated; it has the advantage of bringing the different arrangements which have been described into harmony, and will put an end to the battles which have been fought over the point. First of all we must

[3]Quarterly Jour. Micros. Sci., xxxiii, p. 233, 1892.

[4]Quarterly Jour. Micros. Sci., xxxiii, 81, 1892.

refer to Bury's discovery that the central water vascular apparatus is developed in three pieces, (1) the water tube, (2) an ampulla of an anterior enterocœle, (3) the water pore. He further promises to prove that the left anterior enterocœle becomes the so-called slauchformiger canal, here called the axial perihæmal sinus. In specimens of Cribrella 2 mm. in diameter, I find that there is as yet but a single water pore, which communicates with the cavity of axial sinus; into the latter the free end of the water-tube opens; thus these three spaces are in communication with one another at a comparatively early period. Now this free communication may remain throughout life in many forms, as Cuénot proves, and as I showed in *Cribrella oculata.*

Now the cavity of the axial sinus extends amongst the strands which form the dorsal organ; these spaces we will term intercanicular as distinguished from the intracanicular which are the actual cavities of the strands themselves, and between them there is no free communication, as has already been stated.

In the dorsal organ of echinids there exist epithelium-lined cavities which communicate together, and with a cavity extending longitudinally along the organ; this is termed the canal aquifére annexe by Prouho, and the spaces Kanäle zum Wassergefäss gehörend by Hamann in *Spatangus purpureus.*

Into this space or system of spaces there is free communication on the one hand, with the water tube, and on the other with the madreporic pores, but this only occurs in certain forms (Spatangus, Dorocidaris). Hamann denies that there is any such communication in the regular echinids he investigated; this space, therefore, bears exactly the same position in these echinids that the axial (perihæmal) sinus holds in the asterid; in fact, the one is the homologue of the other. The presence or absence of free communication with the water and madreporic tubes depends on whether the embryonic developmental condition has been retained or lost. There is some difference in the arrangement of the axial sinus in the asterid and echinid, for whereas in the former the sinus contains the dorsal organ, in the latter it is nearly surrounded by the tissue of that organ; that is, in the former the wall of the sinus has only given origin to hæmal strand tissue along our line, whilst in the latter this tissue has been developed from all parts of the wall except a narrow strip on either side of the water tube. If we imagined the wall of the axial sinus of an asterid to contract upon the contained organ, and ultimately to come in contact and fuse with its surface, except along the stone canal, we should obtain a condition closely resembling that described by Prouho in

Dorocidaris; some alteration would have to be made in the structure of the dorsal organ at the same time, for it does not consist as definitely of a number of anastomosing tubular structures as it does in the asterid. Furthermore, we may predict that if, as Bury shows, that in asterids the axial sinus is derived from the left anterior enterocœle, careful investigation will show that the canal aquifére annexe, or axial sinus of echinids, is similar in its development.

In ophiurioids an axial (perihæmal) sinus exists, but according to Hamann it does not communicate with the water vascular apparatus in the adult.

This view seems to me to reconcile the discrepancies in the descriptions which have been published of the anatomy of the region, the differences having apparently arisen from the retention or loss of the embryonic condition of the individual examined.

Wild Animals and Snakes in India.—In the report on the Administration of the Bombay Presidency for the year 1890–91 is to be found the following interesting account of "The destruction of wild animals and venomous snakes": The whole number of people killed by wild animals and snakes within the Presidency, including Scind, during the year 1890, was 1122 as compared with 1160 in the previous year. The number of deaths caused by tigers and leopards was twenty only, of which sixteen occurred in the Khandesh District. In the previous year forty-seven persons were thus killed in that District. In the Broach District seven persons were killed by wolves and three by other animals. The mortality from snake-bite was slightly lower than in the previous year. The most deaths from this cause occurred in Scind, there being 497; the fewest in the Central Division, but 105. In the Northern and Southern Divisions there were 241 and 232 respectively. The number of wild cattle killed by beasts of prey and snakes decreased from 2188 in 1889 to 1883 in 1890. In Kanara, however, the number of cattle killed in 1890 was 938, exceeding the record for the past ten years. The total number of wild animals destroyed during the year was 836, and of snakes 406,092; this was 27,703 fewer snakes than in 1889. The total amount paid as rewards for the destruction of wild animals and snakes during the year was 12,655 rupees, 13 annas and 2 pice (about $5,695.15). (Forest and Stream, April 14, 1892.)

The Phylogeny of the Apteryx.—Prof. T. J. Parker concludes his memoir on the anatomy and development of the Apteryx[5] with the

[5]Phil. Trans., Vol. cclxxxii, 1892.

following summary of the characters supporting the view that Apteryx has been derived from a flying bird: The presence of an alar membrane or patagium; of pterylæ and apteria; of remiges and tetrices majores; the attitude assumed during sleep; the presence of two articular facets on the head of the quadrate; of a pygostyle; of vestigial acromial, procoracoid and acrocoracoid processes; the extreme variability of the sternum, shoulder girdle and wing, indicating degeneration; the occasional occurrence of a median longitudinal ridge or vestigial keel on the sternum; the position of the shoulder girdle and sternum in Stage E; the fact that the skeleton of the fore limb is that of a true wing in Stage F; the early assumption of undoubted avian characters in the pelvis; the typically avian characters, both as to structure and development, of the vertebral column and hind limb; the fact that the brain passes through a typical avian stage with lateral optic lobes; and the relations of the subclavius muscle.

On the other hand the total absence of rectrices tells against this view.

The following characters indicate descent from a more generalized type than existing birds. The characters of the chondrocranium, especially in the earlier stages, but many of these peculiarities, *e. g.*, the absence of interorbital septum, may, however, be correlated with the diminished eyes and the enlarged olfactory organs; the presence of an operculum in early stages (as this structure has not been described in reptiles, it either proves nothing or too much); the presence of a well marked procoracoid in comparatively late embryonic life; and the characters of the pelvis.

Again, the early assumption of their permanent position by the limbs; the late appearance and obviously degraded character of the hyoid portion of the tongue bone; the position of the nostrils and the peculiar mode of development of the respiratory portion of the nasal chamber and the total absence of clavicles are characters in which the Apteryx exhibits greater specialization than other birds.

The general balance of evidence seems to point to the derivation of both Ratitæ and Carinatæ from an early group of typical flying birds or Protocarinatæ.

It has always seemed to me that on the hypothesis of its development from an ordinary reptilian fore limb, *e. g.*, that of a Dinosaur, the wing is one of the most striking examples of the uselessness of incipient structures. If, on the other hand, we suppose it to have been evolved from a patagium which gradually diminished *pari passu* with

the development of its scales into feathers, the difficulty of its first origin is overcome and the presence of the alar membranes is explained.

Ridgway on the Anatomy of Humming-birds and Swifts.—Ornithological literature has very recently been enriched by a monograph upon the Humming-birds, from the pen of Mr. Robt. Ridgway of the U. S. National Museum. It comes to me in the form of a reprint from the Report of that institution for 1890, and is now just issued. As valuable as may be the descriptive part of the contribution, I find it impossible for me to overlook certain very glaring errors our author has fallen into, in regard to the anatomy of the birds he treats. Ridgway still adheres to that now well-nigh exploded notion that the Humming-birds are more or less closely related to the Swifts, and he says "The Humming-birds and Swifts further agree in numerous anatomical characters, and there can be no doubt that they are more closely related to each other than are either to any other group of birds." In setting forth some of the anatomical characters he claims to find in the Humming-birds, in support of this theory, he remarks in regards to the structure of the tongue that "it is hollow and divided at the tip into two slender branches * * * * *." Now the tongue in the Humming-birds is *not hollow*, and I would kindly invite Mr. Ridgway's attention to the very careful dissections of that organ made by the Scotch anatomist W. MacGillivray, and published in the 4th volume of Audubon's Birds of America, and also the results of my own extensive dissections which appeared in *Forest and Stream*, July 14, 1887 (p. 581).

Again our author states that "except in the shape of the bill and structure of the bones of the face, the Humming-birds and Swifts present no definite differences of osteological structure." (p. 290). This statement is not only not true, but as wide of the mark as it well can be, and the wonder to me is, how such a cautious and candid writer as Mr. Ridgway has always proved himself to be, could have allowed his pen to record such an error. As a matter of fact, when we come to compare the skeleton of a typical Swift with that of a typical Humming-bird we find the most radical differences existing in nearly every part, that one can well imagine. As Huxley and a number of other capable anatomists have long ago shown, the skull and associate skeletal parts of a Swift depart not very markedly from the corresponding structures in a Swallow, while they very decidedly differ from the same parts as we find them in a humming-bird. These differences are to be seen in nearly all the rest of the skeleton, when

we come to compare the characters presented on the part of the various bones in a typical Swift, a typical Swallow and a Humming-bird. Not only is this true but the same departures and agreements are to be found in other and quite as important systems of the economies of the several forms mentioned, as in the osseous system. It is several years ago now since I called attention to these facts, but they are very fully set forth in a number of papers of mine which have appeared from time to time in the P. Z. S.; in the Journal of the Linnean Society of London; in *Forest and Stream* and elsewhere.—DR. R. W. SHUFELDT, Takoma, D. C., July 26, 1892.

Zoological News.—Protozoa.—Schütt describes[6] for almost the first time the protoplasmic body of the Peridiniidæ. The richness of the vacuolution is interesting but is not easily described without illustration.

Greef continues[7] his description of the earth Amoebæ. After an account of the general morphology of the group follows a description of the species, of which two are new.

Vertebrata.—A. H. Church has re-studied the peculiar pigment turacin found in the birds of the family Musophagidæ. He finds[8] that eighteen out of the twenty-five species of the family constantly possess this copper containing pigment and that these eighteen species embrace all the members of the genera Turacus, Gallirex and Musophaga, while the other genera of plantain eaters lack it. The analysis of turacin proved very difficult. The best results seem to show the existence of 7% of copper.

Waldeyer describes[9] with some detail the histology of the stomach and intestine of *Manatus americanus*.

F. E. Schulze says[10] that with Golgi's chrom-osmic-silver method one can readily trace free nerve ends in the epidermis of the lip of the fish Cobitis fossilis. In sections one can occasionally trace the deep black nerve fibres clear to the epidermal surface, where they end either abruptly truncate or with a small end knot (knötchen).

[6]Stz. k. Akad. Berlin, 1892, p. 377.

[7]Stz. Gesell. Naturwiss, Marburg, 1891, p. 1 (1892).

[8]Proc. Roy. Soc., li, 399, 1892.

[9]Stz. k. Preus. Akad. Wiss., Berlin, 1892, p. 79.

[10]Stz. k. Preus. Akad., Berlin, 1892, p. 87.

ENTOMOLOGY.

Habits of Prenolepis imparis Say.—**The Winter Ant.**—This ant rarely appears outside of its nest during the heat of the day, from 12 to 4 o'clock (although an occasional individual comes out in the middle of the day), while the little brown Lasius and black Formica are active at that time. It is one of the commonest ants in the Northern States, and is among the earliest to appear in the spring, occasionally appearing during mild winters, but becomes less active in summer, avoiding the heat.

The males and females take their marriage flight in April, as Say has recorded and as I have many times observed, the latest date at which I have found the winged female being May 9. It seems probable, therefore, that the males and females must pass the winter as pupæ or very advanced larvæ, although in nearly all our other ants they hibernate in a much earlier stage and the mature forms do not appear until much later in the season.

This ant bears much resemblance to some species of Lasius, but may at once be distinguished by the absence of a discoidal cell in the wings and the different form of the petiole of the abdomen. The genus Prenolepis resembles Tapinoma in having the scale of the petiole in the worker nearly concealed by the base of the abdomen, but the male and female may be distinguished by having no discoidal cell. The male and female of this species were described by Say under the old genus Formica and it has not since been identified. Roger in his "*Verzeichniss*" has queried whether it might not be a Lasius; it is, however, identical with the European type of Prenolepis, *P. nitens* Mayr, which its author has already recorded from North America. Roger, in 1859, described the female, and in 1862 the worker from European specimens under the name *Formica crepusculascens*, but at the latter date recognized the synonomy with *P. nitens.*

Tapinoma polita, described by Smith from a single worker found in Wales, has been placed by Roger as a synonym of *P. nitens*, but apparently in error, as Smith compared his species with *nitens* and pointed out differences in the antennæ, the scale, and the color of abdomen, which appear to be at least of specific value. *T. polita* was omitted in Mayr's *Index*. Mayr, in "Europ. Form," p. 52, note, considers *polita* a synonym of *nitens*. The synonymy is then :

PRENOLEPIS IMPARIS (Say).—*Formica imparis* Say, [? *Lasius*] Roger, Verzeichniss; *Prenolepis nitens* Mayr: *Prenolepis nitens* Roger; ♀ ☿ (1852), (Nec. *Tapinoma polita* Smith., see Roger and Mayr); *Formica crepusculascens* Roger, ♀ (1859).—WM. HAMPTON PATTON.

Description of the Female of Aphænogaster fulva Roger.—I have found the winged females of *Aphænogaster fulva* in the nest on the 15th of July and flying on July 17. This sex, hitherto undescribed, is closely like the worker, but is larger (length six to seven millimeters), and the metathoracic spines are blunt. The wings are hyaline, the stigma and nervures yellow: there is sometimes present *a second recurrent* vein (received by the second submarginal cell), and in one specimen before me there is a stub of a vein projecting into the first submarginal cell from the second submarginal cell.

WM. HAMPTON PATTON.

Spread of the Horn Fly.—This insect (*Hæmatobia serrata*), which apparently was introduced into the United States from Southern France in 1887, having been first noticed in New Jersey that year, has rapidly spread west, north and south. In a recent issue of the "Southern Live Stock Journal" Mr. H. E. Weed says it is now common in most of the Southern States east of the Mississippi River. It is abundant in Ohio, and has lately been migrating northward in New England. I recently visited a locality (Hartland) in Vermont, a few miles south of Hanover, N. H., where the insect is abundant and is causing considerable annoyance to dairymen. Spraying affected cattle with kerosene emulsion is proving the most practicable remedy.—C. M. W.

Chinch Bugs in New Hampshire.—The chinch bug (*Blissus leucopterus*) has been reported a number of times from New England. In Massachusetts specimens have been collected at Cambridge by Drs. Harris and Dimmock, and at Salem by Dr. Packard. In Maine they have been collected by Prof. H. L. Fernald and Dr. Packard. The latter has also taken specimens at the summit of Mt. Washington in New Hampshire. The present season I have taken three specimens of this species at Hanover, N. H. Two of the short-winged form were taken April 23, under boards along a pasture fence, and one of the normal long-winged form was swept from grass early in June. These were the only specimens that occurred during the season's persistent collecting.—C. M. W.

Instinct of Ammophila affinis.—Dr. P. Marchal has made[1] many observations on the well-known habits of this sand-wasp, which, like other Sphegidæ, paralyzes its victims by stinging the ventral ganglia. He concludes that the habit is not wholly disinterested; that there are many gradations between the insect which kills and that which paralyzes its victims; that the procedure is by no means stereotyped, but variable in details; that the stinging of the ganglia is not necessary to secure paralysis, indeed the sting must, from the nature of the victim, be often effected between the ganglia. None the less, Dr. Marchal admits the wonder of the instinct, and suggests, as Mr. Darwin also did, how the inefficacy of stinging the sides of the victim might lead to the habit of stinging the median ventral line, and eventually the ganglia. Moreover, the median ventral line is often the most convenient and natural line of attack.—*Journal Royal Microscopical Society.*

Some Florida Spiders.—The following species of spiders were collected by me at Inverness, Citrus Co., Fla., during January and February, 1892:

Agalena nævia Bosc.
Lathrodectes mactans Koch.
Gasteracantha cancer Hentz.
Nephila plumipes Koch.
Phidippus miniatus Peck.
Marptusa familiaris Hentz.
Lycosa, a large species.

I am indebted to the kindness of Mr. Nathan Banks for the determinations.—Clarence M. Weed.

Recent Entomological Publications.—Prof. F. H. Hillman issues as Bulletin No. 17 of the Nevada Experiment Station a popular discussion of the woolly aphis of the apple (*Schizoneura lanigera*). "The extreme dry weather of the past spring and early summer has been very favorable for the development and longevity of the aphids, and as the result they are to be found in immense numbers. Those trees surrounded by shrubbery and frequently irrigated apparently are affected less than the others."

Prof. S. W. Williston has lately published[2] the second part of his "Diptera Braziliana." Eight new species of Conops are described.

[1]Arch. Zool. Expér. et. Gen., x, 1892, pp. 23–36.

[2]Kansas University Quarterly, i.

In the same publication Mr. W. A. Snow publishes notes on a collection of Syrphidæ made in Colorado by Prof. F. H. Snow, including descriptions of a number of new species; and Prof. V. L. Kellogg prints some interesting notes on *Melitera dentata* Grote, the larvæ of which eat the soft inner tissue of the prickly pear cactus (*Opuntia missuriensis*).

Two discussions of the insects affecting stored grain have lately appeared. The first, by Mr. H. E. Weed, forms Bulletin No. 17 of the Mississippi Experiment Station, and the second, by Prof. E. W. Doran, forms Bulletin No. 16 of the Maryland Station.

Dr. J. B. Smith continues his contributions to a monograph of the Noctuidæ of Boreal America.[3] In the last instalment he revises the species of the Dicopinæ, and of the genera Cucullia, Xylomiges and Morrisonia.

Mr. H. E. Weed has lately prepared[4] a useful account of the insects affecting cabbage in the Southern States. The article is well illustrated, several of the figures being new.

Dr. C. V. Riley publishes in "Insect Life" (iv, pp. 358–378), a very interesting paper read before the Biological Society of Washington on Some Inter-relations of Plants and Insects. The pollination of Yucca, and the caprification of the fig are chiefly discussed.

Mr. Wm. Beutenmüller publishes[5] four articles concerning Lepidoptera. In two of them notes made by the late Henry Edwards and S. Lowell Elliot are incorporated.

Entomology at Rochester.—The Rochester meeting of the A. A. A. S. was one of unusual interest to entomologists, both from the number present and the interest shown in the papers presented. Most of the entomological papers were presented before the Association of Economic Entomologists and the Entomological Club, while a few of especial interest were presented before the Society for the Promotion of Agricultural Science and Section F of the general Association.

The following papers were presented before the Association of Economic Entomologists, which held its meetings two days before the A. A. A. S.:

[3]Proc. U. S. Nat. Mus., xv, pp. 33–86.

[4]Miss. Expt. Station, Bulletin No. 21.

[5]Bull. Am. Mus. Nat. Hist., iv, No. 1.

Address of President.—Owing to the ill-health of President Lintner, the First Vice-President, Mr. S. A. Forbes, presented the address, which consisted in a review of the more important economic literature of the year, together with a report of the progress being made with bacterial diseases as related to economic entomology.

Notes on *Hypoderus columbœ*, by D. S. Kellicott, noting the finding of this species while dissecting pigeons at the Ohio State University. This is the first record of the appearance of the species in this country.

Additional Notes of Ægeriidæ of Central Ohio, by D. S. Kellicott, giving further details of some of the species of this family not heretofore recorded in Mr. Kellicott's papers.

Two Serious Pear Pests, by M. V. Slingerland, describing the damage done in New York by the pear tree Psylla (*P. pyricola*) and the blister mite (*Phytopterus pyri*).

An Experiment Against Mosquitoes, by L. O. Howard, describing in detail an experiment undertaken to test the recommendation of the application of kerosene to the surface of small pools and stagnant water. Mr. Howard reported marked success with this remedy, and had no doubt but that if used properly many places which now swarm with this pest would be almost entirely free. Owing to the nature of the remedy it probably could not be used upon a large scale with success, but upon small ponds of stagnant water it would be very useful.

Notes on the Bean Weevil (*Bruchus obsoletus*) and *Drasteria erechta*, by M. V. Slingerland, giving the life history and manner of work of these species.

An Enemy of Timothy Grass, by L. O. Howard, describing the work of a homopterous species which had been noticed this season in Green County, New York.

Orthesia insignis as a Garden Pest, by T. D. A. Cockerell, was read by the Secretary, describing the work of this species in Jamaica.

Some Features of Joint Worm Attack, by F. M. Webster, an interesting paper showing the peculiarities of attack and an exhibit of specimens.

Food Habits of N. A. Membracidæ, by F. W. Goding, was read by the Secretary, giving a list of the food plants of the species of this family.

Notes of the Year in New Jersey, by J. B. Smith, giving mention of the principal species doing damage the present year, especially the rose chafer.

Notes from the Mississippi Station, by Howard Evarts Weed, giving account of new injurious species and other notes. Especial attention

was called to the horn-fly and the fact brought out that this species is found most upon dark-colored animals, those of a light color being almost entirely free.

Notes on the Parsnip Web-worm (*Deprassaria heracliana*), by E. B. Southwick, an account of the damage and abundance of this species in New York.

Notes of the Year in Canada, by James Fletcher, root maggots and thrips being especially abundant, while cut-worms are not as abundant as usual.

An Australian Scymnus, by C. V. Riley, a species recently described from the Western States, which is an introduced Australian species.

Further Notes on Mollusks, by F. M. Webster, showing the relation of slugs to Aphides.

Officers elected: President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, J. B. Smith; Secretary, H. Garman.

The Entomological Club of the A. A. A. S. held its meetings during the general meetings of the Association at such times as did not interfere with the Section of Biology. President Schwartz presided. The Secretary, Mr. Marlatt, being unable to be present, Howard Evarts Weed was elected Secretary for the meeting. The following papers were presented:

President's Address by E. A. Schwarz, consisting of a review of the progress made in Coleoptera in recent years and the particular fields of research yet open in this line.

Insects Reared from Gall on *Muhlenbergia mexicana*, by F. M. Webster, giving an account of the species reared, over twelve in number.

A Cutaneous Disease of Cattle Caused by an Arachnoid, by C. W. Stiles, the disease being caused by a species of *Demodex*.

Galeruca xanthomelæna Polygoneutic at Washington, by C. V. Riley, showing that this species was normally two, and, at times three, brooded at Washington.

Galeruca xanthomelæna Monogoneutic at New Brunswick, N. J., by J. B. Smith, showing that the species is normally but single brooded at New Brunswick. In the discussion which these papers brought forth it was thought that the difference in habit between the species at Washington and New Brunswick was not so much in the difference in climatic conditions, as it was in acquired habits. Mr. Riley thought that specimens sent to New Brunswick from Washington would

remain double brooded, while those sent to Washington from New Brunswick would there be single brooded.

The Inhabitants of a Fungus, by H. G. Hubbard, giving a list and account of many species found breeding in a fungus.

Mr. Webster introduced Dr. Edward Murphy of New Harmony, Ind., who gave an interesting account of the life of Thomas Say. Dr. Murphy was personally acquainted with Say for many years before the latter's death.

Notes on a Trip to Nipigon, by James Fletcher, giving an account of the principal species found in this region.

The Arthropoda of Liberia, by O. F. Cook, giving notes of the principal forms noticed there from December to June.

Honey Bee or House Fly, by Herbert Osborn thought that the arrangement of orders as to descent was not natural, but that the orders should be considered as on a level.

Life-History of *Gryllotalpa borealis*, by E. W. Doran, giving detailed descriptions of the different stages of growth.

The Osage Orange Pyralid, by Mary E. Murtfeldt, an account of the damage by a new species upon the Osage Orange.

A Borer in the Stem of the Red Current, by E. W. Claypole, an account of the damage done by *Janus flaviventris*.

The Insect Fauna of the Mississippi Bottoms, by Howard Evarts Weed, giving an account of the principal species collected in the bottom lands along the Mississippi river.

Do Termites Cultivate Fungi? by O. F. Cook, an account of observations in Liberia.

The Committee appointed at the Washington meeting to report upon the advisability of the preparation of a manual of Entomology, made a report of progress and was continued until another year.

The Committee on Entomological Congress in 1893 recommended that the officers of the Club be instructed to call an International meeting of Entomologists at the time and place of the meeting of the Club in 1893. The report was adopted.

Officers elected: President, C. J. S. Bethune; Vice-President, H. G. Hubbard; Secretary, C. L. Marlatt.

Before the Society for the Promotion of Agricultural Science the following were presented.

The Harlequin Cabbage-Bug, by Howard Evarts Weed, an account of the distribution and damage by this species and calling attention to a new and very effective remedy—that of planting a row of mustard through the center of a cabbage field.

The Destruction of Leaf Hoppers, by Herbert Osborn, an account of an experiment with the "hopper dozers" for grass insects.

Several papers of Entomological interest were presented before the Section of Biology, which are mentioned in our report of its proceedings.

As the biological section of the Association was divided into two sections, Botanical and Zoological, no doubt hereafter many papers which have heretofore been presented before the Entomological Club will be presented before the Zoological section.—HOWARD EVARTS WEED, *Agricultural College, Mississippi.*

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

American Association for the Advancement of Science.—The forty-first meeting of this body was held at Rochester, N. Y., in the University Building, commencing Wednesday, August 17, and adjourning Tuesday, August 23. The officers of the meeting were as follows: President, Joseph LeConte, Berkeley, California. Vice-Presidents—A. Mathematics and Astronomy, J. R. Eastman, Washington, D. C.; B. Physics, B. F. Thomas, Columbus, Ohio; C. Chemistry, Alfred Springer, Cincinnati, Ohio; D. Mechanical Science and Engineering, John B. Johnson, St. Louis, Mo.; E. Geology and Geography, H. S. Williams, Ithaca, N. Y.; F. Biology, S. H. Gage, Ithaca, N. Y.; H. Anthropology, W. H. Holmes, Washington, D. C.; I. Economic Science and Statistics, Lester F. Ward, Washington, D. C. Permanent Secretary, F. W. Putnam, Cambridge (office Salem), Mass. General Secretary, Amos. W. Butler, Brookville, Ind. Secretary of the Council, T. H. Norton, Cincinnati, Ohio. Secretaries of the Sections.—A. Mathematics and Astronomy, Winslow Upton, Providence, R. I.; B. Physics, Brown Ayres, New Orleans, La.; C. Chemistry, Jas. Lewis Howe, Louisville, Ky.; D. Mechanical Science and Engineering, Olin H. Landreth, Nashville, Tenn.; E. Geology and Geography, R. D. Salisbury, Madison, Wis.; F. Biology, Byron D. Halstead, New Brunswick, N. J.; H. Anthropology, W. M. Beauchamp, Baldwinsville, N. Y.; I. Economic Science and Statistics, Henry Farquhar, Washington, D. C. Treasurer, William Lilly, Mauch Chunk, Pa.

In the afternoon of Wednesday, August 17, Prof. H. S. Williams, Chairman of the Geological Section, delivered an address on the Scope of Paleontology and its Value to Geologists. In the Biological Section Chairman Prof. S. H. Gage delivered the address on Respiration. The address of Mr. W. H. Holmes was, On the Evolution of the Aesthetic.

Section E, *Geology and Geography.*—Thursday, August 18.—The following papers were read: Terminal Moraines in New England, by C. H. Hitchcock; A Passage in the History of the Cuyahoga River, by E. W. Claypole; Notes Bearing Upon the Changes of the Preglacial Drainage of Western Illinois and Eastern Iowa, by Frank Leverett; Extra-morainic Drift in New Jersey, by A. A. Wright;

The Volcanic Craters of the United States, by Rob't T. Hill; Recent Geological Explorations in Mexico, by Rob't T. Hill; Presentation of Samples from Salt Mines of New York, by S. A. Lattimore.

Friday, August 19.—Paleobotany of the Yellow Gravel at Bridgeton, N. J., Arthur Hollick; The Mining, Metallurgical, Geological, and Mineralogical Exhibits to be Shown at the World's Columbian Exposition, Geo. F. Kunz; Cerro-Viejo and Its Cones of Volcanic Ejecta and Extrusion in Nicaragua, John Crawford; Pleistocene Geography, W. J. McGee; Submarine Valleys on Continental Slopes, Warren Upham; The Homotaxic Relations of the North American Lower Cretaceous, Robt. T. Hill.

Monday, August 22.—Distributions of the Lafayette Formation, W. J. McGee; Cenozoic Beds of the Staked Plains of Texas, E. D. Cope; Exhibitions of Guelph Fossils Found in Rochester, N. Y., Albert L. Arey; The American Mastodon in Florida, John Kost; Some Problems of the Mesabi Iron Ore, N. H. Winchell; The Mathematics of Mountain Sculpture, Verplank Colvin; A New Genus of Marsupialia from the Laramie, E. D. Cope.

Section F, *Biology*.—It was decided that hereafter the Biological Section shall be divided into two, those of Zoology and Botany.

Thursday, Aug. 18.—Notes on Ranunculus repens and its Eastern North American Allies, by N. L. Britton; Notes on a Monograph of the North American Species of Lespedeza, by N. L. Bitton; Contribution on the Digestive Tract of Some North American Ganoids, by G. S. Hopkins; The Root System of Mikania scandens L., by W. W. Rowlee; The "Maxillary Tentacles" of Pronuba, by J. B. Smith; Preliminary Comparison of the Hepatic Flora of Boreal and Sub-boreal Regions, by L. M. Underwood; On the Value of Wood Ashes in the Treatment of Peach Yellows, by E. F. Smith; On the Value of Superphosphates and Muriate of Potash in the Treatment of Peach Yellows, by E. F. Smith; Spikes of Wheat Bearing Abnormal Spikelets, by W. J. Beal; A Study of the Relative Lengths of the Sheaths and Internodes of Grasses for the Purpose of Determining to What Extent This is a Reliable Specific Character, by W. J. Beal; Adaptation of Seeds to Facilitate Germination, by W. W. Rowlee; Report of Biological Section of the Committee on the Naples Table, by C. W. Stiles; Bacteriological Investigations of Marine Waters and the Sea Floor, by H. L. Russel.

Friday, August 19.—Notes on Maize, G. Macloskie; Sketch of the Flora of Death Valley, California, F. V. Coville; How

the Application of Hot Water to Seed Increases the Yield, J. C. Arthur; Heredity of Acquired Characters, by M. Miles; The Production of Immunity in Guinea Pigs from Hog Cholera by the Use of Blood Serum from Immunized Animals, E. A. deSchweinitz; On the Supposed Correlation of Quality in Fruits—A Study in Evolution, L. H. Bailey; The Descent of the Lepidoptera.—An Application of the Theory of Natural Selection to Taxonomy, J. H. Comstock; Non-parasitic Bacteria in Vegetable Tissue, H. L. Russell; Notes on Yellow Pitch-pine, Pinus rigida Mill. var. lutea Kell. n. v., W. A. Kellerman; Germination at Intervals of Seed Treated with Fungicides, W. A. Kellerman; The Fertilization of Pear Flowers, M. B. Waite.

Monday, August 22.—On the Adult Cestodes of Cattle and Sheep, C. W. Stiles; The Fertilization of the Fig and Caprification, C. V. Riley; An Interesting Case of Parasitism, A. H. Tuttle; A Comparative Study of the Roots of Ranunculaceæ, F. B. Maxwell, presented by W.R. Dudley; Do Termites Cultivate Fungi? O. F. Cook; Note on the Appearance of Two Embryo Chicks in an Single Blastoderm, R. O. Moody; The Proposed Columbus Biological Stations in Jamaica, A. H. Tuttle; Adaptation of Plants to External Environment, W. P. Wilson; Notes on Self-pollination of the Grape, S. A. Beach; The Comparative Influence of Odor and Color in Attracting insects, G. B Sudworth; A Preliminary Account of the Brain of Diemyctylus viridescens based upon sections made through the entire Head, S. P. Gage.

Tuesday, August 23.—Notes on some Fresh Water Mollusks, W. M. Beauchamp; The Conditions which Determine the Distribution of Bacteria in the Water of Rivers, J. H. Stoller; Biological Notes on Fauna of Cold Spring Harbor, C. W. Hargitt; Geographic Relationship of the Flora of the High Sierra Nevada, California, F. V. Coville; Variation in Native Ferns, by W. M. Beauchamp; Live-forever Eradicated by a Fungous Disease, D. G. Fairchild: Otto Kuntze's Changes in Nomenclature of North American Grasses, G. Vasey; Revised Nomenclature of the Arborescent Flora of the United States, B. E. Fernow and G. B. Sudworth: On Carphoxera ptelearia, the New Herbarium Pest, C. V. Riley; The Insect Fauna of the Mississippi Bottoms, H. E. Weed; Characteristics and adaptations of Desert Vegetation, F. V. Coville; Shrinkage of Wood as Observed Under the Microscope, F. Roth; Peziza sclerotium, L. H. Pammel; Temperature and Some of Its Relations to Plant Life

L. H. Pammel; Pleospora of Tropaeolum majus, B. D. Halstead; Secondary Spores of Anthracnoses, B. D. Halstead; A Bacterium of Phaseolus, B. D. Halstead; The Significance of Cleistogamy, T. Meehan; The Animal Parasites of Dogs, E. W. Doran; A Preliminary Note on the Anatomy of the Urodele Brain as Exemplified by Desmognothus fusca, P. A. Fish.

SECTION H, *Anthropology.*—Thursday, Aug. 18.—River Pebbles Chipped by Modern Indians, as an Aid to the Study of the Trenton Gravel Implements, by H. C. Mercer; Canyon and Mesa-ruins in Utah, by Warren K. Moorehead; A Few Psychological Inquiries, by Laura Osborne Talbott; Some Indian Camping Sites Near Brookville, Indiana, by Amos W. Butler; On Some Prehistoric Objects From the White Water Valley, by Amos W. Butler; The Early Religion of the Iroquois, by W. M. Beauchamp; Early Indian Forts in New York, by W. M. Beauchamp; Ancient Earthworks in Ontario, by C. A. Hirschfelder; Evidences of Prehistoric Trade in Ontario, by C. A. Hirschfelder.

Friday, August 19.—Anvil-shaped Stones from Pennsylvania, D. G. Brinton; Vandalism Among the Antiquities of Yucatan and Central America, M. H. Saville; The Department of Ethnology of the World's Columbian Exposition, F. W. Putnam; Exhibition of a Large Model of the Serpent Mound of Adams County, Ohio, at 2 P. M., F. W. Putnam; Involuntary Movements, Jospeh Jastrow; Tusayan Legends of the Snake and Flute People, Matilda C. Stevenson; A Skull of a Pig Having a Flint Arrowhead Imbedded in the Bone, E. W. Claypole; Primitive Number System, Levi L. Conant.

Monday, August 22.—On Some Remains From the Oldest River Gravels Along the White Water River, Amos W. Butler; On the Earthworks near Anderson, Ind., Amos W. Butler; Comparative Chronology, by W. J. McGee; Brief Remarks Upon the Alphabet of Landa, Hilborn T. Cresson; The Peabody Museum Honduras Expedition, F. W. Putnam; Explorations on the Main Structure in Copan, Honduras, Marshall H. Saville; Aboriginal Quarries of Flakable Stone, and Their Bearing Upon the Question of Palæolithic Man, W. H. Holmes; Singular Copper Implements and Ornaments From the Hopewell Group, Ross County, Ohio, W. K. Moorehead; The Sacred Pipestone Quarry of Minnesota, and the Ancient Copper Mines of Lake Superior, W. H. Holmes.

Tuesday, Aug 23.—Proposed Classification and International Nomenclature of the Anthropological Sciences, D. G. Brinton; Pre-

historic Earthworks of Henry County Indiana, T. B. Redding; On the So-called Paleolitic Implements of the Upper Mississippi, W. H. Holmes; A Definition of Anthropology, Otis T. Mason; Pueblo Myth and Ceremonial Dances, F. H. Cushing; Demonstration of a Recently Discovered Cerebral Porta, Charles P. Hart; Ruins of Tiahuanaco, Mr. Douglass; Points Concerning Fort Ancient, Selden S. Scoville; Exhibition of a Suite of Prehistoric Pottery from a Mound on the Illinois River, between Peoria and Havana, J. Kost.

Saturday, August 20 was occupied by excursions. These were to Niagara Falls; to Canandaigua Lake; to the Portage Gorge of the Genessee River, which was of interest to geologists; and to Stony Brook Glen, another gorge south of Rochester, which was of interest to botanists. On Wednesday, August 24 an excursion went to the Fish Hatchery of the State at Mumford.

On the evening of Friday, the 19th, the ladies of Rochester gave a reception at the Powers Art Gallery.

Excursions to the Adironkack Mountains and the River St. Lawrence were projected to succeed the Hatchery excursion.

The next meeting will be held at Madison, Wis., beginning the third Thursday in August, 1893. The following is the list of officers for the ensuing year:

President, William Harkness, Washington, D. C. Vice-Presidents, A. Mathematics and Astronomy, C. L. Doolittle, South Bethlehem, Pa.; B. Physics, E. L. Nichols, Ithaca, N. Y.; C. Chemistry, Edward Hart, Easton, Pa.; D. Mechanical Science and Engineering, S. W. Robinson, Columbus, O.; E. Geology and Geography, Charles D. Walcott, Washington, D. C.; F. Zoology, Henry F. Osborn, N. Y.; G. Botany, Charles E. Bessey, Lincoln, Neb.; H. Anthropology, J. Owen Dorsey, Tacoma, Md.; I. Economic Science and Statistics, William H. Brewer, New Haven, Conn. Permanent Secretary, F. W. Putnam, Cambridge (office Salem), Mass. General Secretary, T. H. Norton, Cincinnati, O. Secretary of the Council, H. L. Fairchild, Rochester, N. Y. Secretaries of the Sections, A. Mathematics and Astronomy, Andrew W. Philips, New Haven, Conn.; B. Physics, W. LeConte Stephens, Troy, N. Y.; C. Chemistry, J. U. Nef, Chicago, Ill.; D. Mechanical Science and Engineering, D. S. Jacobus, Hoboken, N. Y.; E. Geology and Geography, Robert T. Hill, Austin, Tex.; F. Zoology, L. O. Howard, Washington, D. C.; G. Botany, F. V. Coville, Washington, D. C.; H. Anthropology, Warren K. Moorehead, Xenia, O.; I. Economic Science and Statistics, Nellie S. Kedzie, Manhattan, Kas. Treasurer, William Lilly, Mauch Chunk, Pa.

Entomological Club of the A. A. A. S.—Thursday, August 18.—E. A. Schwarz, President; Howard Evarts Weed, Secretary. The following papers were read: Preparatory Stages of Colothysanis amaturaria, D. S. Kellicott; Insects Reared From Galls on Muhlenbergia mexicana, F. M. Webster; Notes on the American Bean Weevil, C. V. Riley; Galeruca calmariensis Polygoneutic at Washington, C. V. Riley; Galeruca calmariensis Monogoneutic at New Brunswick, N. J., J. B. Smith; The Inhabitants of a fungus, H. G. Hubbard; Life-history of Zenos, H. G. Hubbard; A Cutaneous Disease of Cattle Caused by an Arachnid, C. W. Stiles.

Friday, August 19.—Life-history of a Fungus, H. G. Hubbard; The Males of Xyleborus, E. Schwarz; Notes on a Trip to Nepigon, James Fletcher; The Synonymy of the Bean Weevil, C. V. Riley; Notes on the Species of Acanthia, Herbert Osborn; Honey-bee or House-fly, Herbert Osborn; Life History of Gryllotalpa borealis, E. W. Doran; Notes on the Arthropoda of Liberia, O. F. Cook; The Osage Orange Pyralid, Mary E. Murtfeldt; Note on a Borer in the stem of the Red Current, E. W. Claypole.

Botanical Club of the A. A. A. S.—Thursday, August 18.—V. M. Spalding, President; D. G. Fairchild, Secretary. The following papers were read: Some Nomenclatorial Problems, N. L. Britton; The Use of the Terms Range, Locality, Station, and Habitat, F. V. Coville; Travels in Paraguay, and Its Flora, Thomas Morong; A Variety of Polypodium vulgare L., New to America, L. M. Underwood; Some of the Rare Mosses of White Top and Vicinity, recently Collected on a Trip to Southwestern Virginia (with specimens), Mrs. E. G. Britton; Symbiotic Growths in the Roots of Ranunculacæ. (Presented by W. R. Dudley), T. B. Maxwell; Galvanotropism, J. C. Arthur; Anatomy as a Special Department of Botany, Emily L. Gregory; A Botanical Terminology, A. A. Crozier; Notes on Some Pear and Apple Diseases, M. B. Waite; Modifications of the Tomato Plant Resulting from Seed Selection, E. S. Goff; Some Rare and Interesting Fungi from Florida (with specimens), W. T. Swingle.

Friday, August 19.—Observations Upon Certain Species of Asclepiadaceæ as Insect Traps, Thomas Morong.

Monday, August 22.—General Notes on the Cryptogamic Flora of Liberia, O. F. Cook; Cultivated Species of Brassica, L. H. Bailey; Notes on the Distribution of Plants in Florida, P. H. Rolfs; North American Cacti, J. M. Coulter; On the Proposed Hand-book of Mosses of Eastern America (with illustrations), Mrs. E. G. Britton;

Weeds and Weed Roots, B. D. Halstead; The Re-discovery of Juncus cooperi, F. V. Coville; Some General Questions in the Classification of Myxomycetes, O. F. Cook; The North American Amelanchiers, N. L. Britton; Observations on the North American Species of Orchidaceæ and Their Nomenclature, Thomas Morong; A New Form of Root Cage, J. C. Arthur; On the Genus Campylopus in North America (with specimens), Mrs. E. G. Britton; Note on a Recent Outbreak of Peach Yellows near Ann Arbor, Michigan, A. A. Crozier; Some Observations on Epigæa repens W. P. Wilson.

Tuesday, August 23.—Notes on the Moutain Flora of Northern Alabama, Charles Mohr; The Botanical Garden Movement in New York, N. L. Britton; A Few Additions to the Hepatic Flora of the Manual Region, L. M. Underwood; Notes Upon a Revision of the North American Naidaceæ, Thomas Morong; Some Noteworthy Features of the Flora of West Virginia, C. F. Millspaugh; Notes on Some Species of Crataegus, N. L. Britton; Observations on the Ripening of the Seeds of Cuphea, Mrs. H. L. L. Wolcott; On the Genus Ditrichium in North America, with One Western Species and Corrections for Two Eastern Species (with specimens,) Mrs. E. G. Britton; Notes on Terminology, Theodore Holm; Notes on Some Fungi Common During the Season of 1892 at Ames, Iowa, L. H. Pammel; Notes on Some Kansas Weeds, A. S. Hitchcock; Notes on the Flora of Block Island, W. W. Bailey; Notes on the Distribution of a Few Plants, L. H. Pammel; Phaenological Notes for 1892, L. H. Pammel.

National Geographic Society of Washington, D. C.—The meetings are on Friday evenings, at 8.30. The following papers were read during the past season: Jan. 29, The Bryant Expeditions to Grand Falls, Labrador, Prof. C. A. Kenaston; Feb. 5, A New Track in Alaska. Dr. C. W. Hayes; Feb. 12, Iceland, Prof. Charles Sprague Smith; Feb. 19, The Temples and Pyramids of Egypt, Mr. Lysander Dickerman; Feb. 26, Military Surveying During the Civil War: Our Side, Mr. Gilbert Thomson, The Other Side, Maj. Jed. Hotchkiss; March 4, The Alaskan Boundary Survey, Dr. T. C. Mendenhall, Mr. J. E. McGrath, and Mr. J. H. Turner; March 11, The Seal Islands, Mr. J. Stanley-Brown; March 18, Coon Mountain, Arizona, and the Diablo Meteorites, Mr. G. K. Gilbert; March 25, The Evolution of Geography, Maj. J. W. Powell; April 1, The Cruise of the "Albatross" Through the Straits of Magellan, Prof. Leslie A. Lee; April 8, Russia, Hon. John W. Foster; April 15, The Cliff Dwellers. Mr. W. H. Holmes; Ocean Temperatures and Fish Migrations, Col. Marshall

McDonald; April 22, The Nicaragua Canal, Hon. Warner Miller or Civil Engineer A. G. Menocal, U. S. N.; April 29, Compensation of the Compass on Board Iron Ships, Lieut. S. W. B. Diehl, U. S. N.; Various Theories of Terrestrial Magnetism, Prof. Cleveland Abbe; May 6, Mesopotamia, Rev. Prof. John P. Peters; May 13, The Gates and Straits of Europe and Africa, Mr. Talcott Williams.

The Biological Society of Washington, D. C.—May 14.—The following communications were read: The Photogenic Organs of Fireflies, Prof. W. H. Seamen; A New Prairie Dog From Mexico, Dr. C. Hart Merriam; Where Salt-water Fishes Hide: Results of Deep-water Seining, Mr. Charles Hallock; Additions to the Flora of Washington, with exhibition of specimens, Mr. Theo. Holm; The Use of Certain Terms in Geographic Distribution, Mr. Frederick V. Coville.

May 28.—Communications: On the Superfamily *Chætodontoidea*, Dr. Theo. Gill; Coon Cave, Missouri, Dr. C. Hart Merriam.

June 11.—The Southern Fur Seal (*Arctocephalus*) at Guadalupe Island, Dr. C. Hart Merriam; Uses of Plants Among the Panamint Indians, Mr. Frederick V. Coville; On *Amarantus crassipes* Schlectendal, Mr. J. M. Holzinger; The Death Valley Expedition—lantern illustrations, Dr. C. Hart Merriam.

FREDERIC A. LUCAS, Sec.

SCIENTIFIC NEWS.

Dr. Carl Berg has been appointed Director of the Museo Publico of Bueno Aires as successor to the late Prof. Hermann Burmeister.

Recent Deaths.—Dr. Veit Graber, Prof. of Zoology at Czernowitz, well known for his work upon Hexapod Embryology, at Rome, March 3, 1892, on a journey to Naples, aged 48 years. Dr. Carl August Dohrn, the President of the Stettin Entomological Society and father of Dr. Anton Dohrn, May 4, 1892, aged 86 years. Riccardo Canestrini, at Padua December 22, 1891, aged 34 years; he was a student of the mites.

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HEREDITY OF ACQUIRED CHARACTERS.*

BY DR. MANLY MILES.

The remarkable progress of science for nearly half a century must be largely attributed to the general recognition and extended applications of the laws of *evolution* and the *conservation of energy*.

In the biological departments of science, evolution has had a predominant influence in suggesting lines of investigation, and in the interpretation of results, while the significance of energy as a factor in all organic processes has not been as fully recognized.

In both vegetable and animal physiology there is a growing tendency to look upon the collocations of matter as incidents, or manifestations of the transformations of energy, and the changes taking place in vital activities are conveniently expressed by the general term *metabolism* that includes the dynamic as well as the material factors, which cannot be separately considered, from the complexity of their intimate relations. Even in the processes of nutrition it appears that the demands for the material elements of tissues are limited, while the expenditures of energy in the constructive processes and their collateral functions are enormous.

It is not my purpose to attempt a general discussion of the conservation of energy as a factor in biological activities, but

*(Read before Section of Biology, A. A. A. S., Aug. 19th, 1892.)

to call attention to some of the processes of nutrition with reference to their import as causes of variation, or the origin of new characters that may be made available through natural selection in the evolution of plants and animals.

The inheritance of acquired characters has been called in question by Weismann, and positively denied by those who accept his theory of the continuity of the germ plasma as originally formulated, and all inheritable variations are assumed to be the result of fortuitous changes in the reproductive germs.

The advocates of this theory confine their attention almost exclusively to gross morphological characters which have been developed and fixed through an accumulation of numerous slight variations for many generations, and ask for direct proof of the complete transformation of these stable characters by changes in the habits of a single individual, while the abundant evidence of physiological, or functional changes in nutritive processes which must be considered as the necessary precursors, and probable causes, of morphological variations, is claimed to be inadmissible.

The processes of metabolism in the nutrition of plants and animals, as now interpreted by physiologists, furnish a rational explanation of the manner in which the reproductive germs may be influenced by functional adaptations of organisms to their environment, which are admitted to be causes of individual variations; and theories of heredity and evolution in which these physiological factors are not taken into consideration cannot be accepted as a satisfactory solution of the problems presented.

Omitting subordinate details which represent the separate links in the chain of events, the processes of nutrition may be summarized in general terms as follows: In plants the chemical elements, and binary compounds on which they feed, are built up by successive steps of increasing complexity and instability into protoplasm, with a storing of the energy made use of in the constructive process, which is derived from the heat and light of the sun. The constructive processes are expressed

by the term anabolism, and the products of the different upward steps are called anastates.

Protoplasm the most complex and unstable of organic substances is the summit of the ascending steps of the constructive processes, and katabolism, which represents the succeeding downward steps of destructive metabolism, then follows, and its products, or katastates, are starch, cellulose, proteids, &c., or what we recognize as the proximate constituents and tissues of plants.

The heat developed in the nutrition of plants is also a product of katabolism, and it represents the difference between the potential energy of the protoplasm, and the potential energy of the other katastates formed from it. This is not however sufficient to enable the plants to maintain an independent temperature, as it is rapidly dissipated by radiation from the extended surface of the foliage, and a large amount is used in vaporizing the water exhaled by the leaves. An approximate quantitative estimate of the energy expended in exhalation was given in a paper read before section I, last year, and published in the May number of the *Popular Science Monthly*.

From their greater complexity the more highly differentiated processes of nutrition in animals are not so readily traced, but the general course and results of metabolism, broadly stated, are essentially the same as obtain in plants. The food of animals consists of the proximate constituents of plants, or the katastates of plant metabolism, and with the exception of oxygen introduced in the process of respiration, they are unable to assimilate the simpler elements on which plants feed.

The first demand of the animal economy is for energy to be used in the constructive processes, and this is derived exclusively from the stored energy of the organic substances of their food through the destructive metabolism involved in the processes of digestion. The proteids, fats and carbohydrates of the food of animals are not directly converted into animal proteids and fats, but the evidence indicates, as pointed out by Dr. Foster, that they are reduced almost to their original elements and then

reconstructed through the agency of animal protoplasm. In no other way can the energy required in animal nutrition be obtained, and as an incident of the destructive metabolism of foods in the process of digestion the materials for the constructive process are provided for immediate use in a simpler form than that in which they were ingested.

In general terms we may then say that the anabolic processes of animal nutrition consist in utilizing the liberated energy in building these disintegrated food constituents into protoplasm, with a storing of the energy as an essential condition of its constitution; and the animal proteids and fats, and in fact the tissues generally are the katastates of its destructive metabolism, that contain less potential energy than the protoplasm from which they are formed; the difference appearing as animal heat, which is supplemented by the destructive metabolism of the tissues involved in their functional activity, or what is popularly called the wear and tear of the system. As in plants, protoplasm is the summit, or highest phase of the anabolic activities, and tissue building must be looked upon as a result of its katabolic transformations.

In the higher animals the nutritive processes are more complex, and the number of upward and downward steps of metabolism is increased through the elaboration of a common nutritive fluid, the blood; but the sum and final outcome of the anabolic and katabolic changes are essentially the same as in the simpler organisms. Energy is used and stored up in the anabolic or constructive processes, and liberated again as animal heat in the "simultaneous and successive" katabolic processes which result in the formation of the various tissues.

Protoplasm is no longer looked upon as a substance of a definite chemical composition and constitution, as it must vary widely in its specific properties in the different species of plants and animals, and even in the different organs of the same animal, and the varieties of protoplasm are therefore innumerable.

In addition to these variations arising from the characteristics of protoplasm in different species, and in their highly differentiated organs, the anastates representing the successive

steps of its elaboration, and the katastates resulting from its destructive metabolism in the same individual, must vary with the ever changing conditions of the environment, and the functional activity of every part of the organism. Individual variations from the prevailing type of the group, or family, are then readily accounted for by a disturbance in the symmetrical balance of the metabolism of the different organs of the body, by prevailing habits, or changes in the environment and conditions of food supply.

In the phases of life from the embryo to the final decline of the bodily powers, there are changes in the relative predominance of anabolic and katabolic activities that we should not fail to notice.

In Dr. Minot's interesting address at Indianapolis "On Certain Phenomena of Growing Old," the sequence of mutations in metabolic activities in the life of the individal were clearly shown. The greater activity of the nutritive functions in youth, and their gradual decline to maturity and old age were strikingly illustrated by an instructive series of statistical diagrams. It was also shown "that with the increasing development of the organism and its advance in age, we find an increase in the amount of protoplasm." This apparently conflicts with the conception of protoplasm as the physical basis of life, and the most plausible inference from these facts, as suggested by Dr. Minot, was that "the development of protoplasm is the cause of the loss of power of growth," and that "protoplasm was the physical basis of advancing decrepitude."

A less obvious, but more satisfactory, explanation is furnished in the outline of the processes of nutrition already presented. It is evident that protoplasm is but a way station, as it were, in the development of tissues, and its destructive metabolism is an indispensable condition of growth, and increase of organic substance. The greatest activity of the katabolic phases of metabolism take place in the embryo and youth, and they then keep pace with the anabolic, or constructive processes of the organism, so that the protoplasm elaborated is used in tissue building as fast as it is formed. When maturity

is reached the demand for new materials in growth ceases, the wear and tear of the system is diminished with less intense demands for the processes of repair. With this falling off in the requirements of the organism for katabolic products including energy, anabolism predominates and protoplasm is allowed to accumulate in the different organs from the check to destructive metabolism arising from the general decline of vital activities.

The hypothesis that the germ plasma, or the reproductive granules it contains, are immortal and entirely independent of the body-plasma, on which is based the assumption that acquired characters cannot be transmitted, appears to be in direct conflict with these physiological laws of nutrition. The protoplasm of the body presents, as we have seen, many differentiated varieties, adapted to the specific function of each organ, and its katastates differ accordingly. The various glandular secretions, the products of nervous and muscular activities, the numerous excretory products, and even the germ cells so far as their molecular structure is concerned must be considered as katastates of the protean varieties of protoplasm. The so-called body plasma must then be looked upon as made up of many differentiated subdivisions, in genetic relations with many katabolic products, all of which are correlated, through vital activities, to act in harmony to serve the entity we recognize as the individual.

The differentiation of a germ-plasma especially concerned in the function of reproduction must be accepted as a physiological factor of the first importance, but we are not warranted in assuming that it is exempt from the metabolic transformations that characterize other living substances.

Herbert Spencer defines life as "the continuous adjustment of internal relations to external relations;" and Dr. Foster expresses substantially the same conception in defining living substance as "not a thing or body of a particular chemical composition, but matter undergoing a series of changes." These definitions fairly represent our present knowledge of vital activities. Metabolism with its "simultaneous and successive" phases of anabolic and kata-

bolic transformations of matter and energy, is admitted to be an essential condition of life in all tissues and elements of the body.

As living matter the germ plasma must be continually undergoing metabolic changes in adjusting its internal relations to its external relations with the body plasma, and interchanges of matter and energy must be involved in its increase and growth.

These constant changes in the substance of the germ cells were not recognized in the original hypothesis of the continuity of the germ plasma. As formulated by Weismann "heredity is brought about by the transference from one generation to another of *a substance with a definite chemical, and above all molecular constitution*," which he called germ plasma, and assumed that it possesses a "highly complex structure conferring upon it the power of developing into a complex organism," and heredity was further explained, "by supposing that in each ontogeny a part of the specific germ plasma contained in the parent egg-cell, is not used up in the construction of the body of the offspring, *but is preserved unchanged for the formation of the germ cells of the following generation.*" Again he says, "the germ plasm, or idioplasm of the germ cell, (if this latter term be preferred), certainly possesses an *exceedingly complex minute structure, but it is nevertheless a substance of extreme stability, for it absorbs nourishment and grows enormously without the least change in its complex molecular structure.*" It is difficult to understand how a living substance undergoing constant metabolic changes can be "a substance of extreme stability," or how it can "grow enormously without the least change in its complex molecular structure."

This assumed stability of molecular structure, and definite chemical composition of the germ cells appeared to be necessary to give plausibility to the claim of immortality, and the further assumption of the non-inheritance of acquired characters. The transmission of a definite, stable, self-propagating substance from one generation to another, uninfluenced by the body plasma, has, in fact, been the shibboleth of those who deny the transmission of acquired characters, but Weismann

himself has retreated from this stronghold of his theory as he found it untenable.

In reply to the criticism of Prof. Vines that it was "absurd to say that an immortal substance can be converted into a mortal substance," Prof. Weismann without hesitation abandons the conception of molecular stability in the germ plasma, and presents his theory of heredity in a new form, that is more in accordance with physiological laws, and at the same time appears to be fatal to the assumptions made by his followers. He says, "does not life here as elsewhere depend on metabolism—that is to say a constant change of material? And what is it then which is immortal? *Clearly not the substance* but only a definite form of activity,"—"*An immortal unalterable living substance does not exist but only immortal forms of activity of organized matter.*" The material continuity of the germ plasma is therefore discarded and replaced with the conception of *a mode of motion* manifest in matter that is continually undergoing metabolic changes.

As the complex molecular substance of the germ plasma is brought into intimate relations with the metabolism of the body plasma through its own metabolic activities, we can readily perceive how acquired habits of the organism in modifying the general and special metabolism of the body must also have an influence on the substance of the germ cells, and through their constantly changing substance on the forms of activity, or modes of motion, that are transmitted from one generation to another in accordance with the new theory. It is then evident that the assumed independence of the germ cells of all influence from the surrounding body plasma, that is relied upon to prove the non-inheritance of acquired characters, derives no support from the present conditions of physiological science.

There are many functional variations in the activities of the different organs of the body that can only be attributed to changes in the environment and food supply in connection with the habits of the individual, and they are so clearly defined and of such frequent occurrence that it seems to be unnecessary to assume fortuitous variations in the germ cells

as the sole factors for natural selection to act upon. In order to evolve two adult forms that are precisely alike in every detail, from two germs with the same identical qualities and tendencies, there must be in each case the same metabolic activity of every part of the system, giving rise to the same series of anastates in the constructive processes of every organ, and the same series of katastates in destructive metabolism, throughout the entire period of growth, which would of course rarely occur from a lack of uniformity in the surrounding conditions of the two individuals.

Individual variations, which are so frequently observed, are then readily accounted for, and there are no physiological reasons for the assumption that the metabolic bias of the organism which gives rise to them, does not likewise have an influence on the germ cells.

The non-appearance of an acquired habit, or peculiarity of the organism in the next generation, cannot be accepted as evidence that it has not been potentially transmitted. The known facts of atavism show that an inherited peculiarity of the organism may be obscured for several generations by other characters, and then reassert itself with all its original intensity. The established family characters, and the acquired habit or peculiarity, of the individual, represent antagonistic factors, and their relative intensity in connection with conditions of development must determine which is to dominate in the offspring.

The transmission of a character, in the first place, should not be manifest in a direct reproduction of the morphological peculiarity, but it must consist in a habit of the organism that leads to the development of the peculiarity in the offspring under favorable conditions for its exercise. The failure of the effects of injuries or mutilations to make their appearance in the offspring cannot be admitted as evidence to prove the non-inheritance of acquired characters, as the physiological activities of the system that are required to produce the morphological peculiarity have not been established, and there can be no tendency of the organism to reproduce them.

The repetition of an acquired habit for several generations, under the same conditions, may be required to establish it as a dominant character over inherited family traits that have been fixed by transmission through a long line of ancestors, but the final result would show that it had been uniformly transmitted, although it had been for a time obscured by other prevailing hereditary tendencies of the organism.

In discussing the evidence relating to the inheritance of acquired characters, or the effects of use and disuse, these antagonisms in hereditary tendencies should not be lost sight of, as the immediate results looked for may be obscured for a time by other predominant influences.

The development of the improved breeds of live stock furnish abundant evidence of the inheritance of acquired characters, but the limits of this paper will only permit a passing notice of its significance. The most successful breeders of domestic animals have acted on the principle that habits of the organs of nutrition which determine the expenditure of the available energy of foods in a special direction, may be cultivated and intensified by persistent exercise for a number of generations, and it is difficult to explain how the gradual improvement of the desired qualities are obtained without the transmission of the modified habit.

The capacity to fatten at an early age, or, for abundant milk production is promoted by liberal feeding in connection with a judicious exercise of the desired habit of the system, and the highest excellence is obtained when the system of management in each generation is especially directed to the cultivation of the habit in its integrity. This is particularly noticeable in the habit of milk production for a more or less extended period in the course of the year. The fashion of raising lambs by nurses of other breeds, and drying up the dam at once to keep her in show condition, resulted in seriously diminishing the inherited capacity for milk production in the females of the family so treated. It is well known to farmers that cows on short pastures and under careless management will form the habit of "going dry" early in the season, and that this habit of giving milk for a short period is not only transmitted but

becomes a marked peculiarity of the females of the family, that is persisted in under better conditions of food supply.

It appears to be unnecessary to assume fortuitous changes in the germ cells to account for the increase, or the suspension of functions that can be so clearly traced to an acquired ancestral habit. Morphological peculiarities are not the only ones that give character to an organism and determine its significant qualities. As in isomeric compounds in chemistry, we find living organisms that are, so far as we can determine, morphologically identical, that differ widely in their habits and general properties. Even in the higher animals the same organ may perform a variety of functions, as the liver for example, and the dominant function for the time being seems to be determined by the requirements of other organs, or of the general system under the special conditions in which it is placed.

There are many species of microbes having the same form and structure that are distinguished by their habits, or the katastates formed in their processes of metabolism, and these katabolic products known as toxines, tox-albumins, and ptomaines, &c., differ widely in their specific properties. Peculiarities in the functional activity of certain organs, or of the general system, appear to be transmitted with the same uniformity and certainty as morphological characters that are more readily observed, although not more significant as distinguishing characteristics.

The experiments of Dr. Dallinger with three species of monads, under prescribed conditions of temperature are of particular interest in showing that the modified or acquired habits of organisms are beyond question transmitted to their offspring. From the rapid repetition of the process of reproduction in these organisms, by fission and sexual fusion, they have marked advantages in experiments for determining the inheritance of new characters.

Throughout the experiments an abundant supply of suitable food was provided, and beginning with a temperature of 60°, which appeared to be the most favorable for them, a gradual increase of temperature was made from time to time as they

were able to endure it, until a final temperature of 158° was reached, in the course of seven years, at which there appeared to be a perfect adjustment of their vital activities to the abnormal environment.

There were critical periods as the temperature was increased, at which a considerable time was required for the organisms to become fully acclimated, and when this was secured, a more rapid increase of temperature was for a time admissable, until another point was reached at which a further rise in temperature could not for some time be made.

No advance was possible for eight months after the temperature of 78° was reached; at 93° a halt of nine months was required; and at 137° a further increase of temperature was not permitted until after twelve months had elapsed. The manner in which the organisms were affected at the critical periods will be sufficiently illustrated by Dr. Dallinger's remarks on their behavior at 137°. He says, "when the 136th degree had been passed there were symptoms of oppression and distress, and on touching 137° this was very manifest," and it was found necessary "to play the thermal point backwards and forwards for three weeks before there was an approach to normal activity and fecundity." At the close of the 12 months, during which the temperature was maintained at 137°, there was an increase in the vacuolation of the protoplasm, which disappeared on raising the temperature 4° in the following month. From this time more rapid progress was made until the final temperature of 158° was reached, when the experiment was terminated by an accident to the apparatus.

At times a slight increase of temperature was not tolerated until the changed habits of their protoplasm provided for the complete adjustment of their vital activities to the new environment, but when this adaptation was fully attained there was apparently developed an increased flexibility of their organization that enabled them for a time to bear a comparatively rapid rise of temperature without any perceptible discomfort, but a limit to this toleration was again soon reached. The organisms that had been trained to live at a temperature

of 158° with apparent satisfaction, and exhibiting a normal exercise of their nutritive and reproductive functions, were however killed when subjected to a temperature of 60°, which was the most favorable for their ancestors.

The acquired habit of adjusting their physiological activities to an abnormally high temperature was undoubtedly transmitted through many thousand generations, and it is evident that the germ plasma was affected by the changes in the environment, either directly, or with greater probability through the modified metabolism of the body plasma.

These experiments clearly indicate the importance of time, in some species at least, as a factor in the complete adjustment of even functional activities to changes in the environment. Seven years of persistent effort was required to bring about a change in the habits, or metabolic processes of these organisms that enabled them to endure, or actually enjoy, the final temperature of 158°, and a much longer time was evidently needed to produce any marked morphological changes.

The transformations of energy in the metabolic processes of nutrition appear to be probable causes of variation, and possible factors in evolution that require investigation. The effects of use and disuse are not obvious in many organs of an obscure nature and undetermined function, some of which may have intimate relations with the dynamic factors of nutrition, and thus serve a useful purpose which we are now unable to perceive.

What are the relations of the so-called ductless glands, like the thyroid and the supra-renal capsules, to the utilization and conservation of energy? Are not the polar bodies of the ovum, and the thymus of the embryo temporary organs to transfer and conserve energy under special conditions that disappear at later stages of development?

What molecular, or other changes take place in the organism to bring about an intense activity of special functions, involving a more complete utilization of energy, as in increased milk production, or in improved fattening qualities?

Questions like these must be answered, to furnish a satisfactory explanation of biological activities, and theories of nutri-

tion and heredity in which energy is not recognized as one of the prime factors in every vital process should be received with caution, and the fallacious arguments based upon them estimated at their real value.

SOME USES OF BACTERIA.[1]

By Dr. H. W. Conn.

Every farmer, of course, appreciates the value of keeping stock, and you all know that you cannot run a farm without your cows, your horses, your sheep, your hens, and your pigs. You do not appreciate, however, that it is just as necessary to keep a stock of bacteria on hand on your farm to carry on your farming operations. The farmer has learned to-day that he must keep a good breed of cows and a good breed of stock in general, but farmers generally do not appreciate that it is equally necessary to keep a good breed of bacteria. You cannot make butter or cheese without cows; you cannot make butter or cheese *satisfactorily* without bacteria. You cannot cultivate your fields without your horses to help you, but all the cultivation that you might give your fields would be useless were it not that these little creatures of which I shall speak this morning come in after you get through and complete the process which you have begun.

Now, probably many of you have never particularly thought that your farm is stocked with bacteria, but they are there. They are in your brooks, in your springs, in your wells, in your rivers; they are in your dairy, in your milk, in your butter, in your cheese, in your barn. They are in the air, they are in the soil, and your manure heap is a paradise for them.

Bacteria are in rather bad odor in the minds of most people, and we are all inclined to look with horror upon them. We have a sort of shrinking when any one speaks to us of the number of bacteria in the milk which we drink. The reason for this, however, is simply an historical one. When bacteria were first discovered it was early noticed that they had a causal relation to disease, and scientists went to work from the very first to investigate diseases in relation to bacte-

[1]From Connecticut Agric. Rep. for 1892.

ria. The result was that after a few years a great deal of information had accumulated, showing that bacteria caused diseases. The so-called "epidemics" are usually the result of bacteria, and with minds intent upon this side of the question scientists did not pay much attention to the good that bacteria might do in the world. It was more interesting to study disease. People are very much interested when you begin to tell them why it is that they have small-pox, why it is that they have yellow fever; the other side of the matter, however, is not so interesting.

But the fact is that the bacteria story has only been half told, and thus far it is the smaller half that has been told, if there is such a thing as *the smaller half.* It is true that bacteria are occasionally injurious to us, but it is equally true that they are of direct benefit to us. Hitherto we have looked upon bacteria as belonging to the medical profession; we think the doctors ought to know about them because they produce disease, but ordinary people do not need to bother themselves with these things. But I think before I get through with my talk this morning you will see that bacteria have a very much closer relation to you as *farmers* than they do to the doctors. It is the farmer to-day who ought to understand bacteriology. It is well enough for the medical man to understand the subject also, but bacteriology has already become a medical subject, while the agriculturist has generally neglected it.

I propose in my talk this morning to point out to you a few of the benefits which you as farmers derive from the agency of these microscopic organisms. I shall divide the subject into four heads. First, *miscellaneous:* At the very outset I am going to say a word or two in regard to yeasts. Now, yeasts are not bacteria, but they are microscopic plants closely related to bacteria, and their agency in nature is very similar to that of bacteria in some respects; so I shall say a word or two in regard to them.

What is the function of yeasts? Yeasts are plants which have the power of growing in sugar solutions, and while growing there they break the sugar to pieces and produce from it

PLATE XXIII.

Map of St. Johns River between Whetstone Point and Lake Monroe.

two compounds; one of them is alcohol, and the other one is the gas which we commonly call carbonic acid (CO_2). We make use of yeasts for various purposes along two directions. We may use them either for the purpose of getting the alcohol or for the purpose of getting the carbonic acid. For instance, you want to bake a loaf of bread; you take your dough, you plant yeast in it and set it in a warm place; now, there is always a little sugar in the dough, and the yeast begins to grow, breaking the sugar to pieces, as I have just stated, and produce from it alcohol and carbonic acid. The carbonic acid is a gas, and as the yeast grows and the carbonic acid makes its appearance in the bread, little bubbles are seen in the dough until presently it becomes filled with these little bubbles of carbonic acid gas which render it lighter. Of course, as the gas accumulates the dough swells, or, as we say, it "rises." Then you bake it, and when you take it out of the oven and cut it open you find that the bread is full of little holes. Those little holes are the remains of the bubbles of carbonic acid gas which the yeast produced, and the object of growing the yeast was simply to make those holes in the bread. The bread is light, and the object of the introduction of the yeast is thus accomplished. You cannot bake a loaf of bread, then, without the agency of microscopic organisms.

In the baking of bread we have an instance of the use of carbonic acid alone. In the manufacture of wine the object of the vintner is to get the other product of yeasts, namely, the alcohol. He grows yeasts in his grape juice, usually depending on those from the air. Again there are carbonic acid and alcohol produced and the carbonic acid in this case passes off into the air during the fermentation, while the alcohol remains behind; when the fermentation has continued long enough a considerable amount of alcohol remains in the grape juice, and thus produces the wine. Similarly, in the manufacture of alcohol or of any of the other alcoholic liquors, such as rum or whisky, the same process is made use of; that is, the little yeasts are planted in some sort of sugar solution, it may be molasses, it may be barley; they grow there; there they produce carbonic acid and alcohol; the car-

bonic acid is allowed to go off into the air and the alcohol remains behind. Then by the processes of distillation the alcohol is separated from the fermenting mass. The carbonic acid is all given off into the air in these cases.

In the manufacture of beer the attempt is made to get both products of the yeast growth. In the making of beer the yeast is cultivated in the same way in the malt; alcohol and carbonic acid both are produced. After some fermentation the beer is put into bottles. A certain amount of fermentation takes place after the bottling. The carbonic acid thus produced is dissolved in the liquid and soon accumulates so as to produce considerable pressure. When the bottle is opened it is this gas which causes the froth at the top of the beer. It is the alcohol which produces the intoxicating quality in the beer, but it is the carbonic acid chiefly which gives the beer its sharp, pungent taste. The alcohol aids, of course, to a certain extent, but the carbonic acid is the chief factor in the taste of beer. It may be a little question whether it is proper to use yeasts in this way to produce rum, whisky, alcohol and beer, with the untold miseries which they involve; nevertheless, yeasts are at the foundation of the gigantic industries connected with distilling and brewing operations.

The farmer makes use of them in the manufacture of cider. Yeast from the atmosphere is planted in his apple juice; it attacks the sugar that it finds there, breaks the sugar to pieces, and produces carbonic acid and alcohol as before. The carbonic acid accumulates during the first day or two, and gives the sharp, pungent taste that is noticeable in sweet cider. Later on the alcohol accumulates in larger quantities, and that gives the taste to hard, sour cider. After the cider has fermented for several days the carbonic acid is of second importance; the alcohol accumulates until you get the strong, sharp, intoxicating hard cider. So much, then, for the uses to which we put yeasts.

Now, leaving yeasts, turn for a moment to the consideration of a few miscellaneous phenomena connected with bacteria. I may take as a starting point this very product that I mentioned last, namely, hard cider. Your yeasts produce alcohol

in your cider. You let your cider stand in a barrel for several months, and little by little a change takes place in it; little by little the oxygen is taken out of the air and handed over to the alcohol, and when the alcohol gets hold of the oxygen it is no longer alcohol; it becomes acetic acid, and your cider is changed into vinegar. Now, it has been determined that it is through the agency of bacteria that the alcohol succeeds in getting hold of the oxygen. Bacteria grow on the surface of hard cider, forming a sort of scum, producing, indeed, what we call "mother of vinegar." These bacteria growing on the surface in some way take oxygen out of the air, pass it down into the fluid, give it to the alcohol, and when the alcohol gets hold of it it becomes acetic acid and you get vinegar where you originally had cider. The manufacture of vinegar, then, is a process dependent upon the growth of bacteria.

The manufacture of lactic acid is a process somewhat of the same character. Lactic acid is not a commercial article of very great importance, but still there are some factories in this country that manufacture it and put it upon the market to be sold for certain purposes. In the making of lactic acid the manufacturer makes constant use of bacteria. By the cultivation of bacteria in milk the milk sugar is changed into lactic acid, which the manufacturer separates from the milk and puts upon the market. So you see that the manufacturer of lactic acid is wholly dependent upon bacteria; he could never produce it without their aid.

Perhaps under this head of "Miscellaneous" I may just refer to a matter which is of considerable practical importance, and that is the matter of ensilage. We do not know very much about the theory in regard to the management of a silo at the present time, but we do know that the whole process of procuring proper and sweet ensilage is a process of properly managing bacteria growth. If you manage the bacteria growth correctly your ensilage will remain sweet and will become a food which is very desirable for your cattle; but if you do not manage the bacteria growth correctly your ensilage will decay, it will become sour, undergo fermentations, and you will suffer

from it. It is, then, to bacteria that the farmer owes his new process of obtaining food through a silo.

I will pass now to the consideration of the second topic, and that is, the relation of bacteria to dairy matters. I have already once or twice before in your meetings brought up this question of the relation of bacteria to the dairy. At the meeting a year ago some of you may remember that we considered the subject of the fermentations of milk, when we saw that all of these fermentations, most of which are very undesirable, are connected with the growth of micro-organisms. Now, so far as milk is concerned, bacteria are pretty much of a nuisance. The milkman does not want them; they produce the souring of his milk; they make his milk bitter or slimy; sometimes they make it blue, and they produce all sorts of abnormal fermentations which a milkman does not want. But I am not to consider that side of the question this morning, and I will pass the subject of milk and turn for a moment to a consideration of the relation of bacteria to butter-making and cheese-making.

Every butter-maker is acquainted with the fact that in the normal process of making butter the cream is collected from the milk and then is allowed to ripen. It is put in some sort of vessels and allowed to stand in a warm place for a day or so, and during that time immense changes are taking place in it. At the end of the time the cream has become slightly soured, it has acquired a rather peculiar, pleasant, indescribable odor, and it has reached the proper condition for churning. During that time our microscope tells us that bacteria have been multiplying with absolutely inconceivable rapidity. They multiply so that they increase during a day perhaps five to six thousand-fold. Each bacterium with which you start when you begin to ripen your cream produces at least six thousand by the end of twenty-four hours, and usually they will produce a much larger number than that. So that bacteria are growing in this ripening cream with absolutely incredible rapidity. Now you butter-makers know that you gain some advantage from ripening the cream, or at least you think you do. You think your butter churns a little easier and that you

get a little more butter from a given quantity of cream if you ripen it, and, above all (and this, perhaps, may be regarded as the chief value of ripening), the butter acquires that peculiar, delicate, pleasant aroma which is essential to a first-class quality of butter, that peculiar aroma which is not acquired if you do not properly ripen your cream before churning it.

Now the explanation of the production of that aroma is simply this: These bacteria are agents of decomposition. Bacteria, as they grow in any solution, tend to decompose it or pull it to pieces. If they grow in an egg they decompose the egg and cause it to putrefy and decay, and when they begin to grow in your cream they begin the same process of decomposition. If you should let your cream ripen for a week or two you would very readily see that the process of decomposition had taken place, and your cream would become very offensive. The moment you begin to ripen your cream the bacteria begin to decompose it. Now as the result of decomposition a great many chemical products are produced, and they have all sorts of smells and tastes. If you should let decomposition go far enough you would get the bad odor of decay, but you do not get that odor when decomposition begins. The first of the decomposition products are rather pleasant in odor and pleasant in taste, and if you churn your cream at that stage of decomposition your butter is flavored with the early decomposition products. This flavor is the aroma of good butter, this is what fancy butter-makers sell in the market and get a high price for. They get a high price, then, for the decomposition products of bacteria, for a proper tasting butter brings a higher price than that which does not have this aroma, and the aroma is the gift of bacteria. You may ask what becomes of the bacteria? It really makes little difference what becomes of them. Some go into the buttermilk, some go off in water used in washing, some go into the butter and the salt kills them. It is no matter where they go. After the butter is churned they are no longer of any importance to you or any one else; their career, so far as the dairy is concerned, is ended.

If the butter-maker owes something to bacteria the cheese-maker owes everything to them. The butter-maker cannot get the proper aroma without the agency of bacteria, but the cheese-maker cannot get anything. Of course, you all know that fresh cheese is very inane and tasteless. Nobody likes fresh cheese. It has sort of a curdy taste and is quite unpalatable. You know, however, that after cheese is made it is set aside for a number of weeks to ripen. It may ripen several weeks, or, perhaps, months. Sometimes in the case of the best cheeses it may be ripened a year or more. Now during that ripening process exactly the same changes are taking place that I have mentioned in cream. The bacteria are growing, are attacking the casein, and pulling it to pieces. They produce many changes in it and cause an accumulation of all sorts of materials which have peculiar tastes, and little by little the cheese is ripened. After a while the cheese begins to have a pleasant taste and then a strong taste, and if you leave it long enough you get a very strong cheese. The longer you ripen a cheese the stronger its taste becomes. An old cheese is always a strong cheese, a fresh cheese is always a mild cheese. The shorter the time you cultivate bacteria in it of course the slighter will be the changes which they produce; the longer you cultivate the bacteria the stronger becomes the cheese.

Now in the ripening of cheese we find the cheese manufacturer's greatest difficulty. Every cheese manufacturer knows that under conditions which seem to be exactly alike he may get good cheese and he may get bad cheese. His cheese may become tainted, it may become spotted with little red spots or some other abnormal conditions may appear which he cannot account for. It would be the greatest boon possible to the cheese-maker if we could in some way enable him to correct his abnormal ripening processes and be able always positively to insure the proper sort of ripening. Now this is plainly a matter which is connected with the planting of the proper kind of bacteria in a cheese and planting them under proper conditions. Different kinds of cheeses are on our markets. We have the Edam cheese, we have the pineapple cheese, we

have the Neufchatel cheese, we have the Limburger cheese and many other kinds. Of course we all know that these different cheeses have very different flavors. Now in the production of these different kinds of cheeses there are different methods used. For instance, in the manufacture of Edam cheese the cheese-maker puts a little slimy milk into the milk that he is going to make into his cheese. That slimy milk contains a certain species of bacteria, and that peculiar species connected with that slimy milk produces the peculiar flavor which we get in the Edam cheese. Sometimes cheese is allowed to ripen soft for a few days before it is pressed, and when thus ripened different kinds of bacteria grow in it and grow in it more rapidly and produce different odors. Experiments have just been begun along this direction which show that it is possible, artificially, to ripen cheese abnormally. You can take certain species of bacteria and grow them in cheese, and you get a very atrociously tasting cheese, and you can take others and get a very good cheese. Now in the use of yeasts we have learned to plant yeast in our bread; we have learned to plant yeasts in our material that we want to ferment, if we are going to make alcohol or if we are going to make beer. The brewer has learned that he must use an artificially prepared yeast. He has learned that if he simply allow the malt to ferment naturally through the agency of atmosphere yeasts he does not know what he will get. It will ferment, undoubtedly, but it will be likely to ferment in an abnormal manner. He, therefore, plants a pure culture of the proper yeasts. But we have not yet learned to plant bacteria in the same way. The cheese-maker has not yet learned to cultivate bacteria as the brewer has learned to cultivate his yeasts. Some day, I think we may say in the not far distant future, after our Experiment Stations have had time to work upon this matter a little longer, the cheese-maker is going to be told of some way in which he can cultivate bacteria as the brewer does his yeast, and then he will know what kinds of bacteria will produce a badly-ripened cheese and what kinds will produce an exceedingly good cheese. The time is coming; it has not come yet, but when it does come we can see that

there will be a tremendous development of the cheese industry in this country.

We know there are four or five hundred species of bacteria in the world. They all produce different sorts of decomposition, they all produce different odors and different flavors, and when our scientific stations have taught our cheese-makers to cultivate their bacteria and plant particular kinds of bacteria in the milk of which they are going to make cheese perhaps we are going to have four or five hundred different kinds of cheese. For aught we can see it may be that the various species of bacteria will produce different flavored cheeses, and perhaps fifty years from now, perhaps in less time, a man may go to the store and order a particular kind of cheese that was made by a peculiar kind of bacteria and another one made by another kind. We cannot tell what possible development there may be of the cheese industry in the future, and whereas, now the cheese-maker must depend very largely upon accident for the particular kind of flavor he is going to get in his product, then he will be able to tell absolutely what he must use in order to be able to produce the flavor that he wants. The result will be a great development of the cheese industry, if such time ever comes.

There will be another advantage in this development when it comes. We all know that once in a while cheese becomes poison. Every one has read in the newspapers accounts of people who have been poisoned by eating cheese. Under certain conditions cheese is very distinctly poisonous, and has produced very many cases of sickness and many cases of death. Now our chemists have studied this poisonous cheese. They have found that it is poisonous because of the production of a peculiar chemical substance in it which they have called "tyrotoxicon." They have found, further, that this tyrotoxicon is a poison produced by a certain species of bacteria. Once in a while that poisonous kind of bacteria gets into milk. The cheese manufacturer is entirely innocent; he cannot help it, because he has no means of knowing anything about it. But occasionally they get in and his cheese is ripened then under the agency of these injurious bacteria. The result is

that his cheese becomes poisonous, and while he is perfectly innocent of any intentional wrong, the evil is done. Now when our cheese-makers have learned to apply to the manufacture of cheese the processes which our brewers have learned in the manufacture of beer, these troubles can be prevented. Twenty years ago a Frenchman, Pasteur, undertook to make an investigation of the diseases of beer, and he found that they could be prevented by the use of a few simple remedies which prevented the growth of the wrong kinds of yeasts or the wrong kinds of bacteria in it. His methods were soon applied to the whole brewery industry in France and also to the manufacture of wine, and the result has been that those diseases which used to be so common and so troublesome to the vintners and the brewers have practically disappeared. So, then, when we in the future learn to apply similar methods to the manufacture of cheese we may hope for the disappearance of all diseases of cheese, including the red specks in cheese, tainted cheeses of all sorts, and also the disease which makes cheese poisonous, as just mentioned.

You see, then, that to the dairy interests bacteria are of distinct value. They give the aroma to your butter, and they give the whole flavor to your cheese, or at least the chief flavor. Without them your butter would not command so good a price in the market; without them your cheese would not command any price.

(*To be continued.*)

CERTAIN SHELL HEAPS OF THE ST. JOHN'S RIVER, FLORIDA, HITHERTO UNEXPLORED.

BY CLARENCE BLOOMFIELD MOORE.

(*First Paper.*)

While the shell heaps of the east coast and of the west coast of Florida have received careful attention, the fresh-water shell deposits of the St. John's River for nearly a score of years have been entirely neglected. In 1875 appeared Prof. Jeffries Wyman's memoir "Fresh-water Shell Mounds of the St. John's River, Florida," embodying in an exhaustive way the researches of the learned author, conducted in person—researches for which his position as curator of the Peabody Museum of Archæology so eminently fitted him. So thoroughly did Prof. Wyman cover the subject, and so conclusive were his deductions that the writer of the present paper would hesitate to attempt any farther work upon the subject were it not that the possession of steam motive power, and the aid of many assistants have put it in his power to explore a large tract of territory hitherto unvisited by any one with a view to the exploration of shell heaps, and to excavate on a scale never before undertaken on the River.

Previous to the work of Professor Wyman, the shell heaps of the St. John's, while their presence was referred to in books of travel, remained uninvestigated by scientists, with the exception of Dr. Brinton. After a personal examination of these shell heaps their construction was attributed by Dr. Brinton to the action of the River (Floridian Peninsula, Page 180). Just how this conclusion was reached is difficult to understand. The writer, in several hundred excavations made in upwards of sixty localities, cannot recall a single one where the agency of man was not apparent. In every excavation of any size, unmistakable traces of ancient fires were discovered, evidenced at times by masses of burnt or calcined shells, and again by layers of shells reduced almost to powder by the

action of the flames. In addition to this, but less evenly distributed throughout the shell heaps, were fragments of pottery and implements of bone, stone and shell.

To Prof. Wyman then belongs the credit of the demonstration beyond question of human agency in the origin of the fresh-water[1] shell heaps of the St. John's.

The territory on the River covered by the writer, beginning near Whetstone Point, nine miles north of Palatka, and ending at Turtle Mound,[2] four miles north of Lake Washington, is about 300 miles in extent, *by water*. (Note A). So devious is the river above Lake Harney that no map attempts to outline its twists and looped-shaped bends, and only estimates as to distance can be made. South of Lake Harney the solid land virtually ceases, and the river from a few feet in breadth at times broadens into great lagoons, or never-ending marsh. At every point where a landing can be effected in high water, or where the palmetto can be seen, is a shell deposit made of the debris of the meals of the aborigines. It is with these swamp shell heaps that these papers will have principally to do, since they are of greater interest, not alone through absence of all exploration hitherto, but also because thėir contracted space more richly rewards investigation.

The shell heaps of the St. John's are refuse heaps simply, and in them refuse alone can be expected under ordinary circumstances; but as articles of value sometimes find their way into ash heaps and dumping places at the present day, so, at times, do weapons and implements, unbroken and in good condition, come to light in the shell heaps. These heaps frequently attain enormous size. Bluffton, the property of Mr. William E. Bird, has thirty acres[3] in shell, and in one part

[1]It will be remembered that large deposits of marine shells, principally of the oyster, exist at Mayport, near the mouth of the St. John's. These shell deposits will not be discussed in these papers, and all allusions to shell heaps will have reference to fresh-water shell heaps alone.

[2]Another mound of this name is situated near New Smyrna on the east coast.

[3]Mr. Chas. H. Curtis, Superintendent of the Bluffton grove, informed the writer that of the fenced portion of the property (forty-five acres) two-thirds consist of shell deposit. The writer, after a careful examination, considers the shell deposit somewhat more.

reaches a vertical height of twenty-five feet from the level of the river.

By far the larger portion of the shell heaps is made up from the remains of fresh-water shell fish, while the bones of various edible animals, principally deer, alligator and turtle, and sometimes of man, crushed, split and occasionally charred, are found in them, but in very unequal distribution.

The stand-by of the aborigines was the *Paludina georgiana*, a fresh-water snail. (Note B). Among the shells of this class, sometimes composing a layer of itself, is found the *Ampullaria depressa*, a snail of great size. The *Unio* (mussel) at times forms a fair percentage in the heaps. The *Glandina truncata*, a land shell, is occasionally met with, while various marine shells from the coast are of not infrequent occurrence.

Prof. Wyman has called attention to a certain difference in size in favor of the *paludinæ* and *ampullariæ* of the shell heaps over those found in the river and its tributary streams at the present day. To this matter the writer has devoted careful attention, and has succeeded in finding *paludinæ* and *ampullariæ* in the shell heaps far larger than any modern shells of the same variety and greatly exceeding in size, so far as the *ampullariæ* are concerned, the measurements given by Prof. Wyman of those from shell heaps. (Note C). As to *paludinæ* no statistics are furnished by him.

Stratification in the shell heaps is of course a matter of accident. The aborigines doubtless made use of the species of shell fish for the time being the most abundant, and such layers are of necessity local and not traceable through the entire heap. The condition of the shells often varies greatly in different portions of the same mound. At times large quantities are found unbroken, without admixture of sand or loam, and so loosely thrown together that they can be literally scooped from the hole; again other portions of mounds are met with where fragments of shell and sandy loam are found in such close connection that the aid of a pick is necessary to effect their removal. It is apparent therefore that some parts of the shell heaps grew up under the aborigines dwelling upon them, and were beaten down and made solid by the press-

ure of many feet for long periods of time, during which periods refuse organic matter was in quantities mingled with the shells; while other parts owe their existence to the dumping of masses of shell by natives not dwelling immediately upon them.

The shell heaps may be divided into four classes in respect to construction:

1. Heaps where shells broken and crushed with a large admixture of sand and loam are closely packed, showing that the mound, by slow accretion of refuse, grew up beneath the feet of the inhabitants.

2. Heaps where unbroken shells with little intermingling of sand lie loosely together, and in which loam is wanting, indicating that the inhabitants living near by carried their refuse to a common dumping place.

3. Stratified heaps, composed of alternate layers of unbroken shells and of crushed shells with sandy loam, testifying that the mound has at different times served as place of residence and refuse heap.

4. Heaps where materials of the first and second classes closely adjoin, leading to the belief that the original heap, used for domiciliary purposes, has been supplemented by a contiguous pile of debris.

To these might be added a fifth class, comprising perfectly symmetrical mounds of shell in the form of truncated cones, possibly constructed from materials of a shell heap for use as ceremonial mounds or as watch towers. Mounds of this class are found at Bluffton and at Huntoon Island, and still await a careful investigation.

No effort will be made to demonstrate the existence of cannibalism among the makers of the shell heaps, as the mass of evidence collected by the writer so entirely corroborates the theory of Prof. Wyman that further discussion on the subject would seem unnecessary. The writer, however, is strongly of the opinion that cannibalism was not practiced by the earliest makers of the shell heaps, for while bones of the lower animals are found at every depth throughout the shell heaps, human bones, treated in a manner similar to those of the edible lower

animals, were not upon a single occasion, among several hundred excavations, met with below two feet from the surface. It will be remembered that upon one occasion only were human remains found by Prof. Wyman at a considerable depth; namely those at Osceola Mound (now Crow's Bluff, Lake County), and that they were not particularly broken. The articular portions of several had been severed by a cutting instrument, a suspicious circumstance. The writer, however, until farther facts are adduced, will remain of the opinion that cannibalism, as a custom, was practiced only towards the close of the period of the shell heaps.

Another conclusion arrived at by Prof. Wyman seems based upon the strongest probability. When after a long and careful search in a shell heap no pottery is brought to light, it may be considered that the makers of the heap lived at a time when the method of its manufacture was unknown. Pottery filled so great a want in the lives of the aborigines and was so extensively used by the makers of the shell heaps where it is found at all, that it seems impossible to account for its absence upon any hypothesis other than the one suggested. One fact relating to pottery which Prof. Wyman neglects to state is that in many shell heaps pottery is found to a certain depth only, after which it entirely disappears. In other shell heaps pottery, plain and ornamented, is found in association for a time, after which unornamented pottery alone is found. These points in connection with the pottery of the shell heaps have been noticed in so many scores of cases that the writer is convinced that many shell heaps were in process of formation contemporaneously with the first knowledge of the art of pottery making and its subsequent development. It will be remembered that Prof. Wyman was hampered in his researches by inadequate assistance in respect to the manual labor of digging, and it is likely that certain facts buried deeply beneath the surface escaped him. It is to be regretted that in nearly every case he neglects to state the *depth* at which weapons and other implements were found, and whether pottery ornamented or plain, or both, was met with in association. It is well known that later Indians occupied the shell heaps as places of

residence long after their completion; some doubtless cultivating them, and hence distance from the surface is a most important factor in determining the origin of shell heap relics of all sorts.

Before proceeding to a detailed account of certain shell heaps hitherto unexplored, the writer feels it in justice to himself to state that in all excavations conducted by him not one spadeful of debris has been thrown out except in his presence; that in no case has he relied on hearsay testimony, and that dimensions are derived from measurements, and not from estimate.[4]

LIST OF SHELL HEAPS HITHERTO UNEXPLORED ON, OR NEAR THE ST. JOHN'S RIVER, FLORIDA.

1. Near Whetstone Point, nine miles north of Palatka, west bank.
2. Shell heap three miles north of Palatka, west bank.
3. Barrentine's, on Trout Creek.
4. Shell Ridge, in swamp half a mile north of Horse Landing, east bank.
5. Shell heap one mile north of Welaka, east bank.
6. Two shell heaps about half a mile apart, right hand side going up Salt Run, Lake George.
7. Shell heap and fields Hitchen's Creek, south of Volusia Bar.
8. Large shell heap in swamp near Morrison's Creek, south of Volusia Bar.
9. Two shell fields near Morrison's Creek.
10. Shell bluff near mouth of Blue Creek, south of Volusia Bar.
11. Shell heap, Duval's, Blue Creek.
12. Mt. Taylor, in swamp east bank of St. John's, one mile south of Volusia.
13. Bird's Island in river, south of Volusia.
14. Small shell heap west bank, opposite Bluffton.
15. Shell heaps, ridges and fields, Tick Island on Spring Garden Creek, near Lake Dexter.

[4]The writer's collection of objects found in the shell heaps may be seen at the Wagner Free Institute, Philadelphia.

16. Shell heap, Spring Garden Creek, east of Lake Woodruff.

17. Mosquito Grove, west bank, four miles north of St. Francis.

18. Shell field on second lagoon south of Hawkinsville.

19. Shell heaps and ridges Thornhill Lake, near Lake Jesup.

20. Huntington's west bank, one mile north of Lake Harney.

21. Small shell deposit opposite Huntingdon's east bank.

22. Shell heap in hammock about two miles east of Cook's Ferry.

23. Shell heap and fields, Raulerson's, southeast end of Lake Harney.

24. Small shell heap in prairie, west bank, about one mile south of Lake Harney.

25. Shell heap in prairie near Econlockhatchee Creek, right hand side going up, about one mile from the St. John's River.

26. Shell heap west side of Puzzle Lake, south of Econlockhatchee Creek.

27. Shell heap about six miles south of Puzzle Lake, west bank of St. John's River.

28. Shell heap about one-quarter of a mile south of preceding.

29. Shell heap in marsh east bank in sight of preceding.

30. Orange mound, about twenty-one miles by water south of Lake Harney.

31. Persimmon mound, east bank near Lake Ruth.

32. Indian fields, Lake Ruth.

33. Rock Island, one mile east of Orange mound.

34. Shell heap on Lake Clement, or Cane Lake.

35. Shell heap opposite above.

36. Paw Paw Island.

37. Long Bluff, two shell Fields.

38. Opossum Bluff, east bank.

39. Mulberry mound, near Lake Poinsett.

40. Half-way mound, between Lakes Winder and Poinsett.

41. Fort Taylor, southwestern end of Lake Winder.

PLATE XXIV.

Map of St.Johns River
between Lake Monroe and Lake Washington.
Enterprise
Lake Monroe
Sanford
Ginn's Grove
Thornhill Lake
Black Hammock
Lake Jessup
Huntington's
Cook's Ferry
(King Philips Town)
Lake Harney
Raulerson's
Puzzle Lake
Salt Lake
Shad Lake
Persimmon Mound
Orange Mound
Luffmans Lake.
Lake Ruth.
Indian Fields
Rock Island.
Lake Clement.
Paw Paw Mound
Long Bluff.
Possum Bluff.
Mulberry Mound.
Lake Poinsett.
Halfway Cabbage
Lake Winder
Fort Taylor
Moccasin Mound
Turtle Mound.
Lake Washington
Indian River

42. Moccasin Island, southeast end of Lake Winder.
43. Turtle mound, four miles north of Lake Washington.

NOTE A.

EXTENT OF FRESH-WATER SHELL HEAPS ON THE ST. JOHN'S.

As stated, the extreme southerly point reached by the writer was Turtle mound, four miles north of Lake Washington. At this point the river is so obstructed by islands, formed from masses of floating plants, that further progress by the channel in any form of boat is impossible between that point and Lake Washington. Row boats, however, by making use of cut-offs, known to natives, can reach the Lake and go beyond without much difficulty. The river extends, after leaving Lake Washington, to a point considerably south of the Sawgrass Lake, and very many trappers questioned by the writer were agreed that shell heaps are met with to the very source of the river and that on them alone can camping places be found among the surrounding marshes. So universal was the testimony to this effect that the writer considers it safe to accept it.

The most northerly fresh-water shell heap is presumably near Whetstone Point, nine miles north of Palatka. Prof. Wyman, though thoroughly acquainted with the river below, failed to find any shell deposits farther north, and the writer during sixteen seasons spent in Florida, of which much time was passed upon the river, has been unable to discover or to hear of any fresh-water shell deposits lower than Whetstone Point. A large number of persons familiar with the river in every capacity have been qüestioned; some perfectly acquainted with the shell heaps farther south, but no clue as to the existence of more northerly shell heaps has been gained.

Until proof to the contrary be adduced the northern limit of the shell heaps must be considered as stated above. And this gives rise to an interesting question—why on the ninety-one miles of river below Whetstone Point are no shell deposits found? Some of the most advantageous places of abode on the river are met with north of Palatka, while tributary streams are abundant. The writer has found *ampullariæ* at

Magnolia, fifty-three miles from the river's mouth, while shell collectors state that fresh-water snails are sparingly found in tributary creeks near Jacksonville, twenty-five miles from the sea. Beyond this point no data have been obtained. After careful consideration of these facts the writer thinks it probable that the discontinuance of the line of shell heaps was a necessity imposed upon the aborigines through an insufficient supply of their staple article of diet, and that this scarcity arose through a certain admixture of salt water coming with the tide from the sea.

The tide in the St. John's is noticeable as far south as Lake George, and it is stated on competent authority that barnacles are found on pilings at Palatka, hence it is very probable that an admixture of salt water in which only the most hardy fresh-water mollusca can live is met with in the neighborhood of that town. It is also not improbable that conditions now existing at the mouth of the river were not found in earlier times, and that the absence of a bar admitted a greater flow of tide water, in which event fresh-water shell fish within reach of the brackish water would be even less numerous than at present.

NOTE B.

AS TO THE METHOD OF COOKING APPLIED TO SHELL FISH.

The method of preparation of the shell fish as a medium of diet by the aborigines must be considered an open question. Upon no shells at any distance from the various fire places are marks of fire traceable, from which it would appear that roasting was not the method employed.

While boiling would leave no trace on the shells, a question naturally arises as to the method of accomplishment of this form of cooking by those living on certain heaps to whom the manufacture of pottery was unknown. If baskets of wicker or bowls of wood, in which the water was heated by stones previously exposed to the action of fire, were used, such stones would of necessity be comparatively abundant in the shell heaps. But they are wanting.

The theory that the shell fish were eaten without recourse to cooking would seem untenable, since too many shells are found in perfect condition. It is true that a certain proportion of the *ampullariæ* and *paludinæ* (about ten per cent. in some of the heaps) is perforated, and that these perforations were artificially made, since there are no predatory fresh-water mollusks; still it is difficult to see of what assistance such a perforation would be in the extraction of the shell fish without the aid of boiling water. It is therefore apparent that the subject of the culinary methods of the savages[5] who built the earlier shell heaps of the St. John's—a question never before touched upon—opens a field for careful research.

NOTE C.

SIZE OF THE SHELLS OF THE MOUNDS AS COMPARED TO RECENT SHELLS OF THE SAME SPECIES.

While the shells of *ampullariæ* and *paludinæ* from certain shell heaps greatly exceed in size those of recent specimens, as the subjoined table, kindly compiled by Mr. H. A. Pilsbry of the Academy of Natural Sciences of Philadelphia, will prove, the shells met with in certain other mounds of the St. John's show little, if any, excess in size over living specimens to be found in the neighborhood. In a number of the older mounds (if absence of pottery be taken as an indication of greater antiquity, and there seems to be no reason why it should not) shells are much smaller than in certain mounds at times but a few miles distant, where pottery is found in abundance. It would seem therefore, that there must have been a middle period when these fresh-water shell fish attained their highest degree of development, and that that period was reached after the completion of certain shell heaps and during the construction of others. Neither Buffalo Bluff, Orange Mound nor the portion of the shell heap on Hitchen's Creek, where very large shells were found by the writer, can be considered as belonging to the older shell heaps of the St. John's.

[5]Lewis Morgan (Ancient Society, New York, 1877) draws the line between savagery and barbarism at the point where pottery comes into use. The distinction is approved by Fiske "The Discovery of America" vol. 1, page 24, et seq.

TABLE OF MEASUREMENTS OF AMPULLARIA DEPRESSA.

Dimensions in Millimetres, 25 equal 1 inch.

LOCALITY.	Height.	Diameter.	Remarks.
Orange Mound...........	80	80	Largest specimen on record.
Buffalo Bluff..............	75	77	
Recent Specimen.........	55	53	Largest in collection Phila. Acad. Nat. Sciences.

TABLE OF DIMENSIONS OF PALUDINA GEORGIANA.

LOCALITY.	Height.	Diameter.	Height of Aperture.	Remarks.
Mound on.......... Hitchen's Creek...	50	33	25	Largest specimen seen.
	40	27		Average from 25 meas.
	45	24	18	Elongated specimens. (Variety *Altior*).
	42	25	15	
Recent Specimens.... Hitchen's Creek.......	30	23	17	Largest of 200 seen.
	27	20	15	Average size.
Recent Specimens....	33	25		Largest recent specimen in collection of Phila. Acad. Nat. Sciences.

It will be noted that the aperture of the shell, in specimens from the mound, measures from one-half to about one-third the length of the shell; but in recent specimens, from the adjacent creek, it is in every case over one-half the shell's length. No living specimens on record attain the size of the average shells of some of the mounds, as will be seen by the figures in the first column.

A GEOMETRICAL REPRESENTATION OF THE RELATIVE INTENSITY OF THE CONFLICT BETWEEN ORGANISMS.

By John A. Ryder.

For our present purpose an organism may be thought of as a geometrical point in space. If such a point or organism is surrounded upon all sides by a homogeneous medium, such as air or water, it may be thought of as similarly related to the six faces of an enveloping or circumscribed cube, provided, the point or organism be placed at the point where the four diagonals bisect each other that pass through the cube from one to the other of its four pairs of trihedral angles or corners. The point or organism may be thought of as if placed at *o* in the diagram (fig. 1); the diagonals, which determine its position in such an ideal or imaginary cubic portion of space, will be, *ab*, *cd*, *ef* and *gh*. The relations of the point *o* would be equally well determined by the three axes, *x*, *y*, *z*, joining the centres each to each of the three pairs of faces of any such ideal enveloping cube. We may suppose further that the point or organism at *o*, if it moves from place to place, simply alters the position in space of the ideal enveloping cube of which it is always conceived to be the central point.

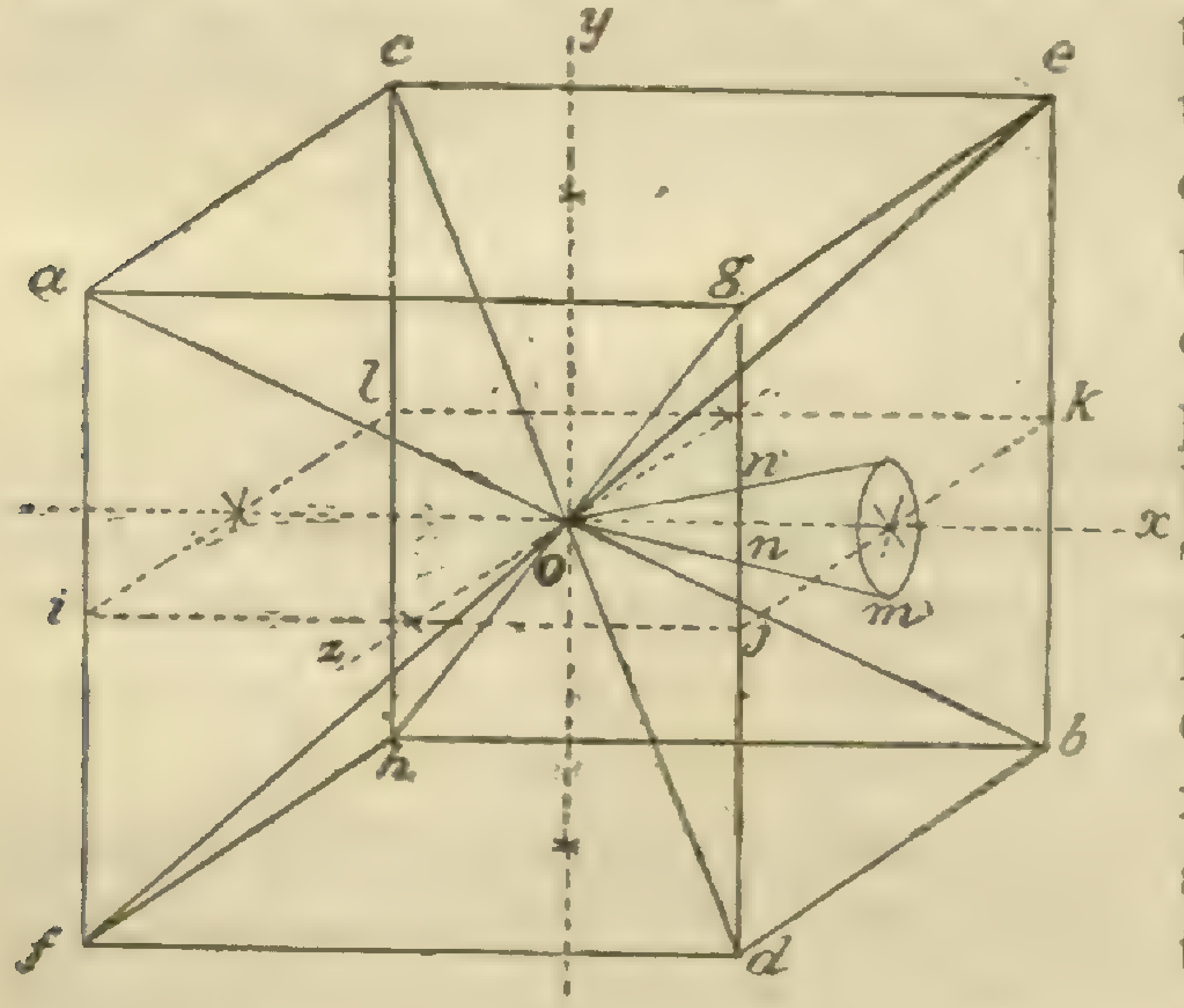

Fig. 1.

The possible number of ways of approach from every point on the surface of such a cubical fragment of space to the point

o at its centre will be $6a^2$, if it is assumed that there are *a* number of points on any and every edge, such as *ac*, of every one of the six faces of the cube. Since the enveloping cube has six faces, its cubic contents are equal to six square pyramids with the four sides of their bases with a length of *a* units or points, and with their vertices at *o* and with their bases formed of the six faces of the cube. If *a* represents the number of points lying in one of the edges of a side of the cube, it is obvious that the possible number of paths of approach toward *o* from all points at the surface of the enveloping cube must be $6a^2$, that is the whole number of points found in the bases of the six pyramids forming the sides of the enveloping cube.

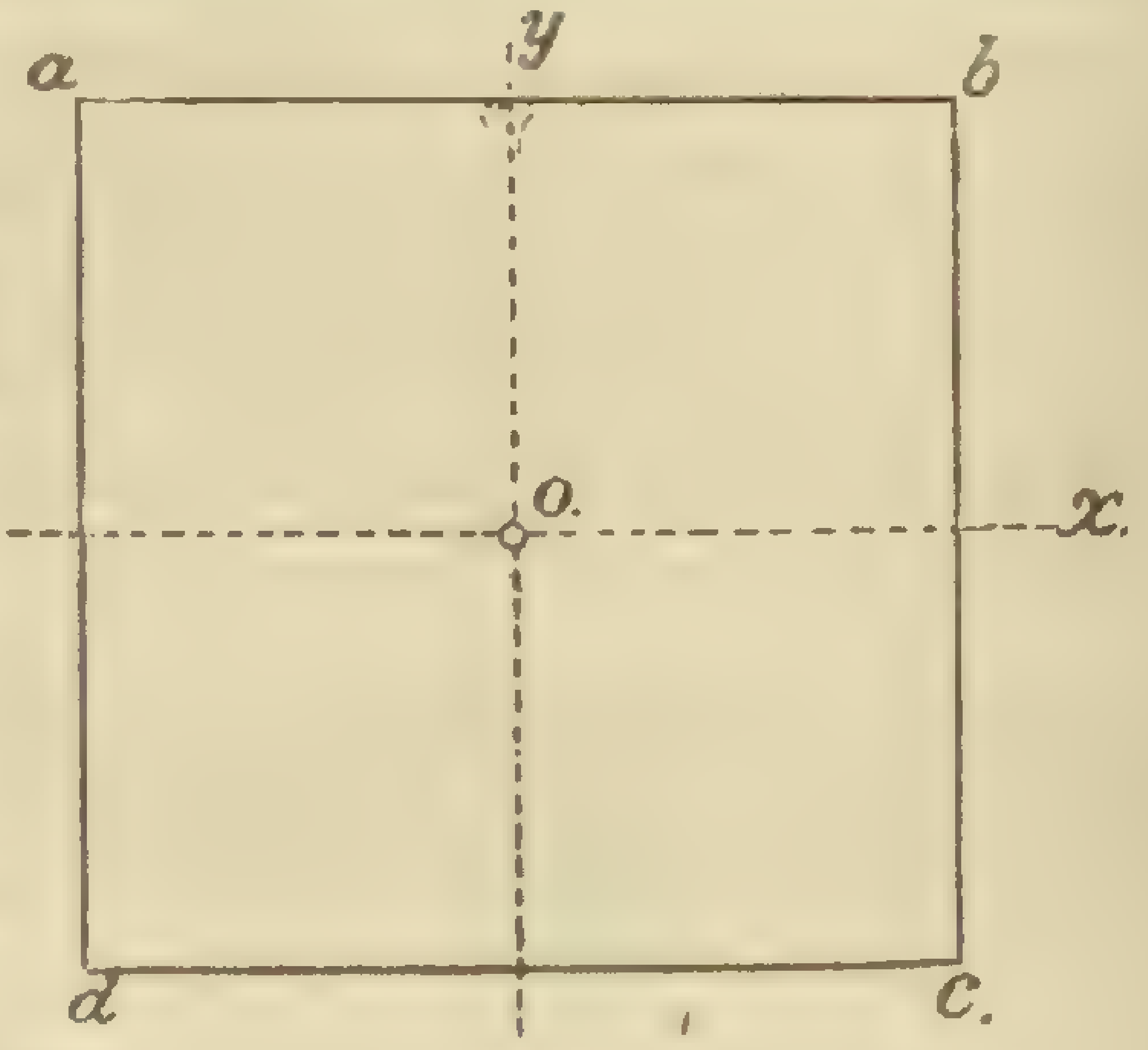

Fig. 2.

If we now suppose a fish swimming in water or a gnat flying in the air, in the same relations to a cubical fragment of its surroundings, as represented in the diagram, (fig. 1) or relatively to the faces of a cubical envelope of water or air, as *o* is to the six faces of the cube, *acge, agfd, gedb, fhdb, acfh* and *cehb*, we can, by assigning some definite numerical *value* to *a*, the length of any and every edge of the enveloping cube, as *ac*, for example, determine the number of directions in which it can be assailed by its enemies from the outside of its cubical envelope of air or water. If $a=100$, $6a^2=60{,}000$, so that any form swimming in water or flying in air is liable to be approached by enemies under such conditions as will amount to 60,000 possibilities of attack.

As a second supposable case, and if the point *o* were placed on a horizontal and impenetrable plane, cutting the enveloping cube into two equal parts through its four vertical sides along the lines *ijkl*, such a plane coinciding furthermore with the two horizontal axes *x, z*, of the cube, then would the point or organism *o* be accessible only from any direction lying in the upper face *acge* of the enveloping cube or the upper halves of

its four vertical sides *agij*, *acil*, *celk*, *gejk*. Then also, would the point or organism *o* be accessible only from $a^2+4\,(\frac{a}{2}a)=3a^2$ points or from only half as many as in the preceding case. That $3a^2$ must represent the possible number of paths along which *o* may now be approached, must be self-evident from the fact that the plane through *x* and *z* divides the ideal enveloping cube supposed in the first case into similar and equal halves, since one-half of $6a^2=3a^2$. If an organism is supposed to lie or move at *o* on the plane determined by *ijkl*, on the ground for instance, as a reptile, or at the bottom of the sea as a flounder, then will the possibilities of attack by enemies, with the factor *a* still equal to 100, be only 30,000.

A third case may be supposed where the point *o* is placed in the centre of a square plane with four equal sides (fig. 2) *ab*, *bc*, *cd* and *da* and with axes *x* and *y* across its two dimensions. Here if the number of points in any side of the square are *a* as before the number of points of approach will obviously be 4a, since there are as many pencils of lines converging at *o* as there are sides, namely, four. If, as in the case of heavy terrestrial organisms, attack by equally heavy or formidable enemies is only possible from every direction on a plane and not from every point on the surface of the whole or upper half of an enveloping cube, the possibilities of attack now sink to 400 or to only $\frac{1}{150}$th of the number in the first supposed condition and $\frac{1}{75}$th in the second.

A fourth case may be supposed where the point *o* may lie in the centre of a plane surface, which is perforated at the same point more or less deeply, so that *o* may, if it be a sensitive organism, retreat more or less into such perforation or cavity, now supposed to be excavated in a solid substratum. The small opening, as indicated in Fig. 2, into which *o* may retreat obviously represents only a very small part of the plane *abcd* and *o* is now accessible to an enemy only through some fraction of the number of points represented by a^2. This is still better shown in Fig. 1 where *m* is the circular periphery of the opening in one of the faces of the now solid cube enveloping *o*, on all sides except one, *o* now lying at the bottom of a cavity with parallel or converging sides *nn*. The accessi-

bility of o now becomes much reduced or only through m. If the lines nn Fig. 1 are produced we would have as the measure of accessibility of o, if, say the diameter d of m were $\frac{1}{5}$ of a, the number of points in jk, the number of points in d would be 20, the square of $\frac{1}{2}$ of 20, or the square of the radius of the circle m into π gives us the number of points in the area of m, which is 314 reckoning upon the basis of the arbitrary value assigned to a from the beginning. If, furthermore, still reckoning upon the same basis, we were to suppose the diameter of m to embrace only two points, then $r^2=1$ and the number of points of approach toward o would be only 3+. In this way by diminishing the diameter of m zero would be rapidly approximated and the accessibility of the organism at o become more and more difficult and greater and greater protection ensue against the attacks of enemies.

A fifth case may be supposed in which a cover may be developed or manufactured by the organism to close up the opening m supposed to exist in the preceding case, such as the lid made by a trap-door spider to close the entrance to its burrow. Other similar cases are presented by the test-bearing, univalve, operculate mollusks, the tubicolous and operculate worms and protozoa, or the valves of lamellibranchs or cirrhipeds. In such cases an approach is made toward total inaccessibility, the number of paths of approach and consequently of attack practically vanish to zero for all attacking forms which cannot bore into or crush the shelly covering of such prey.

The application of such geometrical conceptions and algebraic formulæ to represent the relative intensity of the struggle of organisms amongst themselves, under diverse relations to space, surfaces and cavities, must be obvious, if the point o be regarded as an organism and accessible to attack from $6a^2$ or 60,000 possible directions in the first case, from $3a^2$ or 30,000 possible directions in the second, from $4a$ or 400 in the third, from 314 to 3 in the fourth and from 0 in the fifth.

A condition similar to the fifth obtains where mimetic coloration exists. We may conceive an organism at the point o on a plane, such as a mimetically colored flounder assuming the tints of the plane upon which it rests, or a mimetic butterfly

or other organism at some point o in space, where the surroundings render mimetic coloration useful and where such surroundings now have tints so like the organism itself as to amount to positive and absolute concealment so long as the organism is quiescent. In this case accessibility to enemies again sinks to zero.

Parasites also are protected not only by virtue of their concealment within their hosts but also by the possible mimetic coloration of the latter.

Recapitulating, our series gives us the following comparative values:

For organisms swimming in water or flying in air, we may say that their accessibility *inter se* and liability to attack is from 60,000 directions.

For sessile organisms or those lying on a plane, their accessibility *inter se* and liability to attack is from 30,000 directions.

For heavy terrestrial forms their accessibility *inter se* and liability to attack by their fellows is from 400 directions.

For burrowing or tubicolous forms accessibility sinks to any where from 314 to 0 directions of approach.

For testaceous, operculate, mimetic or parasitic forms accessibility to enemies sinks to almost or quite 0.

That the intensity of the struggle for existence under the diverse conditions supposed varies as greatly as is indicated by the figures seems to be in a great measure supported by the facts of adaptations. For example, the high specialization of flying and free-swimming organisms must at once appeal to us in verification of the preceding statement. The high temperature of birds, the pneumaticity and specialization of their skeletons; the somatic, tracheal respiration and relatively high temperature of the bodies of flying arthropoda is proof of the high rate at which energy is dissipated and the effectiveness of the mechanism through which such dissipation is effected. Similarly, it may be said that only the free swimming types of fishes, such as the herrings, mackerels, sharks, etc., are "clipper built" for high velocities of motion while those that depend upon stealth, concealment for the capture of their prey and escape from enemies, are either depressed in form or even

much flattened, as flounders, for example, besides being usually mimetically colored. In these cases the figure of the body is so obviously correlated respectively with a capacity for a high velocity of motion and a capacity for only a low velocity of motion that there seems to be reason to suspect that the figure of the body is also correlated with a widely varying intensity of conflict with enemies and conditions in the struggle for existence, such as seems to be established by the various geometrical laws of their space relations during that conflict or struggle. If there have been forms which have developed in such directions as to give them greater celerity and consequently greater command over their surroundings in every direction there have been others which have been equally successful, often by the aid of mimicry, in getting into out-of-the-way corners and hiding-places in Nature where the possible number of approaches from their enemies have been also greatly reduced. Which of the two is the most advantageously situated it would be difficult to decide. For, while the swift and alert type must expend a great amount of energy in motion, the sluggish and concealed must vegetate and in a sense continually tend to degenerate in some one or other respect. The comparative rarity with which free-swimming or pelagic forms develop a tendency to bud or throw out stolons is perhaps to be connected with the great amount of energy expended in setting up motion. Where such colonial forms are mobile, most, be it observed, are obviously adapted as colonies for such motion, as the *Siphonophora*, chain *Salpæ* and *Pyrosoma*, for example. In other cases: sessile *Protozoa Porifera*, *Cœlenterata*, *Tunicata*, loss of active, free motility seems to end in a tendency to produce buds and stolons and develop colonial forms. It would seem as if the material and energy expended by the freely moving forms in active motion prevented the development of stolons and coherent colonies, intensified their specialization for active motion, and in some cases reduced their fertility. In the case of sessile forms or those with quiescent habits it would seem that the consequent saving of the material and energy of motion was compensated

by the development of colonies, buds, stolons or increased fertility.

The numerical series representing the gradual diminution of the intensity of the struggle of animal organisms amongst themselves, passing from very active, free moving forms to sessile and concealed forms is: 60,000, 30,000, 400, 314–3, 0. These marked contrasts seem to be well founded and highly significant. They probably indicate that in a completed theory of organic evolution, the rate at which energy is dissipated in the form of motion by a given animal organism must by taken into account. The possible number of directions of motion and attack under different conditions, it is scarcely necessary to add, have here been calculated upon the basis afforded by modern geometry, from certain relations of the point and line.

EDITORIALS.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

—We have received prospectuses of a World's Congress Auxiliary of the Columbian Exposition to be held in Chicago in 1893. This auxiliary is to consist of a number of gatherings of persons interested in human progress. The president, Mr. Charles C. Bonney, says with truth, that "it is impossible to estimate the advantages that would result from the mere establishment of personal acquaintance and friendly relations among the leaders of the intellectual and moral world, who now, for the most part, know each other only through the interchange of publications, and perhaps the formalities of correspondence." That such meetings properly conducted must be both pleasant and profitable there can be no doubt. If, on the other hand, they are occupied by the debates of uneducated or silly persons, they will not benefit the Exposition nor the participants. Careful criticism of all communications should be exercised by a competent committee of each division; and a chairman be selected for each, who shall know how to maintain the relevancy of discussion. In order to secure the former object written abstracts of communications should be sent to the committees in advance of the sessions.

The classification of the subdivisions of the congress as issued to date might be somewhat improved. Thus, there is a department of moral and social reform, and separate departments of temperance and Sunday rest, which are obviously moral and social questions. The two latter departments should be merged in the first-named. There is also a department of art, and a separate department of music, which is one of the arts. In the subdivisions of the departments some anomalies present themselves, as Microscopy, which is an art, under Science and Philosophy; and separate sections are allowed for African and Indian (query Hindoo) Ethnology, while all other races are included under but one head. Just what the Department of Religion is to accomplish outside of moral and social reform, for which there is another department, it is difficult to imagine. It may be safely predicted that theology will not be the subject of discussion. So far as the scientific interests of the congress are concerned we may be sure they will be well cared for. The names of Lindahl in Geology, Forbes in Zoology, Bastin in Botany, Putnam in Archeology, and others, are satisfactory guarantees.

—WHILE civilized man has gained much in the higher departments of mind, his powers of observation are frequently inferior to those of lower races. Particular white men who have lived long on the frontiers of civilization may be as acute in their perception as savages, but as a rule the general statement above made is true. Remarkable illustrations of incapacity in this direction in the inhabitants of cities occasionally present themselves. A family in Philadelphia recently buried a corpse in good preservation as that of son and brother, but on their return home they were confronted by the son and brother alive and well. The body was particularly identified by the mother by various peculiarities which she pointed out. In view of this and similar instances of malidentification, which are not uncommon, it is evidently necessary for courts of justice to examine with great care alleged identifications, especially those made by children. It is to be feared that in some instances serious mistakes have been made. Such errors will grow less frequent as the faculty of critical observation is cultivated in our schools by practice in laboratories of natural science.

—THE reduction in the appropriation to the United States Geological Survey need not seriously curtail its usefulness. Its organization has been hitherto unnecessarily expensive, and very different from that of the surveys which preceded it. There was, for instance, an office of "chief geologist," a position heretofore held by the director of the survey. Its recent abolition is a step in the right direction. The geologists in charge of departments under the old surveys went into the field and performed the work. Under the present survey younger men were sent into the field and reported to the chiefs of the departments. So far as the utility of this double system of officers is concerned, one or the other of them might well be abolished. In his report to the Secretary of the Interior under resolution of the Senate of July 16, 1890, Major Powell, director, stated that the survey employed sixteen geologists, eight paleontologists, seven physicists, and eighty topographers, with their assistants. There were also twenty assistant geologists and twelve assistant paleontologists. The topography appears to be in excess, and no doubt the survey will do good work with a smaller force of "assistant topographers" than hitherto.

The reduction of salaries paid to professors already occupied in institutions of learning, will also benefit the survey.

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PLATE XXV.

Protohippus placidus Leidy.

RECENT LITERATURE.

Occurrence of Underground Waters in Texas, etc.[1]—In a report on the occurrence of artesian and other underground waters of Texas, New Mexico and the Indian Territory, Mr. Robert T. Hill gives first a brief resumé of the principles that govern the distribution of underground waters, and secondly an elaborate discussion of water conditions of the regions named.

Observation demonstrates that the best conditions for securing underground water are not in consolidated or mountain rocks; but, on the other hand, sandy upland plains, like the great Jornado del Muerto or filled-in river valleys like that of the Rio Grande, are the most favorable locations for imbibition and storage of underground waters. By taking advantage of this law, hundreds of wells have been obtained upon the supposed waterless plains, such as the Llano Estacado and the Franklin-Hueco basin north of El Paso.

The areas treated of by Mr. Hill consist of the eastern division, the central denuded region, the mountain systems, remnantal plains of later or allied age to the Rocky Mountain uplift, and basin plains that lie between the mountain blocks of the Trans-Pecos region.

The water conditions of these subdivisions may be summed up as follows:

Throughout the eastern division, with few exceptions, wells can be obtained at moderate depths.

In the central denuded region good wells (non-flowing) are abundant, but the structure of the region is unfavorable for any large flow of water.

In the Red Bed Area, also, surface wells are abundant, but no results have been obtained in boring for artesian water. The inclination of the strata in Indian Territory and Oklahoma warrants the conclusion that experiments in these regions are justifiable.

The fourth division, comprising the Llano Estacado and the Raton Las Vegas Plateau, was once continuous with the eastern division, but is now separated from it by a vast plain of erosion. The Llano

[1]On the Occurrence of Artesian and Other Underground Waters in Texas, Eastern New Mexico and Indian Territory, west of the 97th Meridian, by Robert T. Hill, Assistant Geologist of the U. S. Artesian and Underflow Commission; Prof. Robert Hay, Chief Geologist.

Estacado is singularly void of surface water, but throughout its whole extent there is an underground supply stored in the mortar beds and grits of Cenozoic age. It is the most remarkable sheet of underground water in the land. The structure of the Raton Plateau is inimical to favorable artesian conditions.

The Great Basin regions are characterized by the occurrence of disconnected mountain blocks separated by wide plains, most of which in comparatively recent times were occupied by vast inland seas. These basin plains are covered with loose unconsolidated sediment derived from the bordering elevations. The water precipitated upon the mountains finds its way to the plain, where it is quickly imbibed by the porous soil, percolating downward until it reaches an impervious stratum. This water is available by bored wells, but it may or may not possess, according to the stratifications and topography. The possible success of artesian borings in these basins is also suggested by the fact that numerous flowing wells have been obtained in similar basin deposits in California, Colorado and Utah. The paper is abundantly illustrated by wood-cuts, diagrams, sectional drawings, maps and charts.

Evolution in Science, Philosophy and Art.[2]—For a number of years it has been the custom of the Brooklyn Ethical Association to choose a subject for study during the winter months, and as an incentive to work a series of lectures are given, followed by discussions of the topic assigned for the evening. The present volume comprises seventeen lectures on the subject of Evolution, grouped under the several heads of Science, Philosophy, and Art.

The opening lecture of the course, on the work of Alfred Russel Wallace, shows that the general drift of American thought is toward the neolamarkian school of evolutionists. Chemistry, Electric and Magnetic Physics, Botany, Zoology, Optics, and Form and Color in Nature are monographed by specialists in those departments.

The group under the head of Philosophy comprises the life-work, and philosophical system of Prof. Ernst Haeckel; an exposition of the scientific method, a presentation of the principles of Spencer's Synthetic Philosophy, Life as a Fine Art, and a discussion of the doctrine of evolution, its scope and influence.

The progress of art in general is traced in the lectures on Architecture, Sculpture, Painting, and Music. Thus it is that while some of

[2]Evolution in Science, Philosophy and Art. Popular lectures and discussions before the Brooklyn Ethical Association, New York. D. Appleton & Co., 1891.

the questions discussed have a purely speculative interest, others have a practical bearing on every-day life.

Outlines of Lessons in Botany.[3]—Miss Newell has adopted a pleasant method of introducing the study of plant life to children. This volume (Part 2) treats of flowers and fruit. Beginning with the early bulbous plants she gives directions for observing, comparing and describing the various parts of the flower. As the lessons progress through the spring flowers, common weeds, composites and summer flowers, opportunity is given to discuss in detail the functions of the different organs, cross-fertilization, æstivation, inflorescence, the seed, the fruit, and the morphology of the flower. Points are brought out by pertinent questions, and so by easy stages the child is taught to observe for himself. Brief descriptions of sixty families of flowering plants are given in addition to the ones described in the lessons. The illustrations are numerous and good.

[3]Outlines of Lessons in Botany, by Jane H. Newell. Part 2, Flower and Fruit, illustrated by H. P. Symmes. Ginn & Co., Publishers, Boston, 1892.

General Notes.

GEOLOGY AND PALEONTOLOGY.

The Glacial Catastrophe in Savoy.—The torrent of ice and water which caused such a lamentable loss of life at the baths of St. Gervais in July last was so extraordinary that M. Vallot, Director of the new Mont Blanc Observatory, determined to explore the region from which the avalanche descended with a view to discovering the cause and to prevent the recurrence of so horrible a catastrophe. In company with M. Ritter and two guides he ascended the mountain to the base of the Aiguille du Goûter. Here they found an apparently insignificant glacier, the Tête Rousse, which proved to be the source of the outbreak. This glacier forms a plateau nearly horizontal. It advances over an inclination of 40° between two converging ridges into a basin which has for an outlet a narrow rocky ravine. The front of the glacier has been torn away, exposing an enormous arched cavity, filled recently with ice. This cavern communicates by a narrow passage strewn with blocks of ice, with a sort of crater 270 feet long and 133 feet deep, having perpendicular walls of polished transparent ice, an indication of prolonged contact with water.

It is the opinion of M. Vallot that a lake had been formed at the bottom of the glacier and crater. This water had undermined the ice crust over the upper cavity. When the ice crust collapsed the tremendous pressure transmitted to the lower grotto caused the rupture in the anterior part of the glacier. This explains the enormous quantity of water precipitated at once into the valley, carrying with it the soil of the banks, forming a torrent of liquid mud mixed with ice-blocks and rocks.

It is estimated that 100,000 cubic metres of water and 90,000 of ice issued from the glacier. It is possible the sub-glacial lake may re-form, and in view of the possibility M. Vallot advises blasting the rocky bottom to provide an escape for the water.

The Iron Ores of the Lake Superior Region.—Mr. C. R. Van Hise has brought together under this title all the more important conclusions upon the subject which have been reached in recent years by the Lake Superior Division of the U. S. Geol. Survey.

It is now definitely known through Irving's researches that these ores, like many of a later age, are derived from carbonate of iron.

The ores now mined occur in two geological series, the lower Huronian and the upper Huronian. The lower Marquette series may be taken as a type of the first, and the Penokee ores of the second.

The Penokee ore deposits are roughly triangular in cross-section. They usually dip to the east. They rest upon impervious formations below, and generally grade upward into a porous ferruginous chert or slate of iron formation. The lower Marquette series vary greatly in shape, lie for the most part upon impervious formations in pitching troughs, and grade above into broken and porous material of the ore formation.

As to the genesis of the ores, the author thinks that all evidence goes to show they are concentrations produced by downward percolating waters. These waters removed a part of the original material of the iron-bearing formations at the places where the ore-bodies occur, and introduced iron oxide almost simultaneously. This explains the forms, positions, and relations of the ore deposits. They rest upon tilted walls or troughs of impervious formations because water has here been converged. They occupy the place of the original ore formation because this is easily penetrated by water, because it was rich in iron carbonate, and because the constituents other than iron oxide are readily soluble.

The interchange of silica and iron oxide is observable. The change from the ore bodies to the rocks above is a transition, and along this transition zone the silica bands die out by a gradual removal. In the iron formation proper the silica is frequently in solid bands alternating with bands richer in iron. In passing toward the ore the stratum is porous, due to cavities left by the removal of the silica, but before all the silica is removed, iron oxide begins to be introduced, and finally the solid body of iron ore occupies the place of the siliceous band.

The iron ore does not appear throughout the Huronian rocks of Lake Superior, but only in definite formations which constitute a small percentage of the entire Huronian series.—*Trans. Wis. Acad. Sci. Arts and Letters, Vol. viii.*

The Geology of Nicaragua.—In an abstract of Notes from a Geological Survey in Nicaragua Mr. J. Crawford states that Nicaragua, geologically considered, can be divided from north to south into five zones, differing from one another in lithological, mineralogical, and structural characters.

The first division embraces the central mountainous parts, and contains Laurentian, Taconic, Cambrian, and Siluric rocks, also Devonic rocks unconformable to the last. The second division, parallel to that just named, and extending to within a hundred miles of the Caribbean Sea, contains sediments of Carboniferous, Permian, and Mesozoic ages, covered unconformably by Cenozoic and modern formations. In some of the rivers of this division are rich gold placers. The third division is the delta on the eastern coast. Evidence furnished by alluvial deposits and coral reefs indicates recent subsidence until a few years ago, when elevation commenced. The fourth division is on the western side of the first (central) division. Its rocks are generally similar to those of the second division. In some places dykes are connected with lava-flows. In the valley of the Rio Viejo is a tertiary mammaliferous deposit with Toxodonts, etc. The fifth division occupies Western Nicaragua, and contains several small crater-lakes of the Vicksburg, Yorktown, and Sumter periods; all the post-Mesozoic Nicaraguan volcanoes are in this division.—*Quart. Jour. Geol. Soc.*, 1892.

Cope's Lectures on Geology and Paleontology.[1]—This series of lectures prepared for the Extension Course of the University of Pennsylvania forms a basis for the study of geology. They are rather elementary in character, and at the end of each chapter will be found directions as to collateral reading and home work.

Part 1, Geology, opens with a short introduction defining the subjects which constitute the science of geology. The author then takes up in turn structural, dynamic, historic, and lithological geology. The salient features of each are put concisely, but clearly, so there can be no misunderstanding of the subject. The latest discoveries in American stratigraphy are noted. An addition of importance is a chart which gives the realms, systems, and series of interior and coastal America, Europe, and other countries, showing at a glance their relations to each other.

Part 3, Paleontology, embodies the latest reliable information as to the characters of the Vertebrata, their homologies, affinities, and geological position. The author adopts the division of the vertebrata into four superclasses, Hemichorda, Urochorda, Cephalochorda, con-

[1]Syllabus of a course of lectures on Geology and Paleontology. Part 1, Geology, Part 3, Paleontology; by E. D. Cope, Ph. D., Professor of Geology and Paleontology in the University of Pennsylvania. Phila., 1891. For sale by A. E. Foote, 4116 Elm Ave., Phila.

taining one class each, and Craniata, subdivided into five classes, viz.: Agnatha, Pisces, Batrachia, Monocondylia, and Mammalia.

The greatest changes in classification, as a consequence of the latest accessions to the knowledge of the subject, will be found in the Pisces.

In classification the definite characters are brought into prominence and analytical keys are adopted as the most perspicuous method of exhibiting them.

Carefully prepared charts give accurate ideas as to the geological range of the different orders, and of the time relations of these to each other.

The books are profusely illustrated with cuts and drawings, many of which represent American material.

Crook on Saurodontidæ from Kansas.[2]—In this paper the author gives anatomical descriptions of some species of Portheus and Ichthyodectes from the Niobrara chalk of Kansas, and makes some comments on the systematic position of the Saurodontidæ and of the Erisichtheidæ. The anatomical work is good, and some needed rectifications of original descriptions are made. We find it necessary, however, to make some comments on the systematic part of the work, in which are to be found numerous oversights.

In the first place the author has not observed that I have on several occasions published the fact that the name *Daptinus* Cope is a synonym of *Saurodon* Lea, which was proposed many years previously. It was from this genus that I gave the family the name first proposed, of Saurodontidæ. The fact that Prof. Zittel many years later gave this name to a very distinct family does not authorize the giving of a new name to the family first so called by me, as is done by Mr. Crook. It only signifies that another name should be used for Prof. Zittel's family, as I have proposed in THE AMERICAN NATURALIST, 1889, p. 858 (Macrosemiidæ). The statement that my original Saurodontidæ embraced a genus which does not pertain to it should be supplemented by the information that I removed this genus (Erisichthe) from it, and established a new family for it (Erisichtheidæ), only two years later[3] than the date of the publication of my volume on the Cretaceous Vertebrata. In the next year I made the Erisichtheidæ the type of a new order, the Actinochiri,[4] adopting, however, the name Pelecopter-

[2]Ueber einige fossile Knochenfische aus der Mittleren Kreide von Kansas; von Alja Robinson Crook. Palaeontographica, Vol. xxxix. 1892, p. 107.

[3]Bulletin U. S. Geolog. Survey Ter., 1877, iii, p. 822.

[4]Proceeds. Amer. Asso. Adv. Science, 1878, p. 299.

idæ, as I had already proposed this name in the work above quoted (1875) before I was aware of the affinity or identity of the genera Pelecopterus and Erisichthe. All this has been overlooked by Mr. Crook.

Mr. Crook further states that only three genera, Portheus, Ichthyodectes and Saurodon (Daptinus), belong to the family. But Hypsodon and Saurocephalus should not be omitted. He also observes that I gave the name Portheus because of the resemblance of the fishes it embraces to the bull-dog; and that the word does not occur in any Greek or Latin lexicon. Just why Mr. Crook thinks that Portheus has any relation to bull-dog he does not tell us, but if he will look in the Greek lexicon he will find that πορθέω means to destroy, and from this verb the substantive is easily derived. Finally the species of Ichthyodectes, regarded as new by Mr. Crook, and named *I. polymicrodus*, is probably the *I. arcuatus* Cope.[5] This species is one of several from this horizon which would have been figured long ago by me had not it been for the policy pursued by the present U. S. Geological Survey.

Mr. E. T. Newton, in an otherwise able article[6] some years ago, resolved that the catalogue name Protosphyraena of Leidy should be used instead of Erisichthe. Apart from the fact that Leidy's name was published without description, thus putting it outside the pale of recognition, the name was made to apply to two very different species, *P. ferox* and *P. striata*. *P. ferox* belongs to the genus called by me Erisichthe, while the *P. striata* belongs to another genus. According to the usual custom, the Leidyan name, if used at all, should be applied to the *P. striata*, since the *P. ferox* had been referred to another genus. This rule was, however, not followed by Mr. Newton, and Mr. Crook imitates him.—E. D. Cope.

On the Permanent and Temporary Dentitions of Certain Three-toed Horses.—At a meeting of the Philadelphia Academy held Oct. 4, 1892, Prof. Cope described the changes in the characters of the superior molars of the *Protohippus placidus* Leidy, resulting from age and wear, and the characters of the dentition of colts of Protohippus and Hippotherium. He pointed out that in stages of wear up to middle life the *P. placidus* is the *Hippotherium gratum* of Leidy, and that then the protocone fuses with the paraconule, and the

[5] Proceeds. Am. Philosoph. Soc., 1877, p. 177; *Portheus arcuatus* Cope, Cretaceous Vertebrata, 1875, p. 204 (not figured).

[6] Quarterly Jour. Geol., London, 1877, p. 505.

animal becomes a Protohippus. He had not observed this to take place in any other species referred to Hippotherium. In both these stages the enamel borders of the lakes are more or less plicate, and the posterior loop of the anterior lake is present. With further wear the plications, including the loop, disappear, when the molars agree in their characters with the *Protohippus parvulus* Marsh. These observations were based on specimens from the Loup Fork beds of Nebraska, Kansas, Colorado and Texas, where the species is abundant.

The speaker exhibited the molar dentitions of three colts from Wyoming and Texas, and a part of one from Colorado, all from the Loup Fork beds. He showed that these represent the genera Merychippus, Parahippus, Hypohippus, and Anchippus of Leidy, and six species of the same author. He thought it probable that Anchippus belongs to a colt of Hippotherium, and Parahippus and Hypohippus to Protohippus, while he was not certain as to the reference of the type of Merychippus (*M. insignis*). He pointed out that the characters of the individual temporary molars differ in the different teeth of the series, and also differ at different stages of wear. As with the permanent dentition, in some species the temporary molars are always simple, while in others the enamel borders are more complex. In the latter case the pattern becomes more simple in some respects with prolonged wear. He was able to correlate the temporary and permanent dentitions of *Protohippus perditus* Leidy with certainty, and those of *P. pachyops* Cope and *P. mirabilis* Leidy with much probability.

Prof. Cope further pointed out that the temporary dentition in these three-toed horses is more simple than that of the adult, in some cases resembling very closely the permanent dentition of the ancestral Anchitherium in molar structure. In this the horses differ from the higher Artiodactyla, where the temporary molars are equally complex or more so than the permanent molars.

The accompanying plates (XXV, XXVI) illustrate the statements made above. In Plate XXV we have the gradations in the pattern of the grinding surface of the molars in the *Protohippus placidus* Leidy. Figs. 1 and 2 represent the more complex hippotheroid stage of early wear, and in Fig. 3 a simpler stage of the same. Figs. 4, 5, and 6 represent the more worn protohippoid stages with greater and less complicity of pattern. That individuals differ as to the stage at which this occurs is shown by Fig. 6, where the crown is less worn than in Figs. 4 and 5. In Fig. 7 we have an old animal with crowns fully worn, showing the full protohippoid pattern, with simple pattern. Fig. 8 is the corresponding inferior series. All natural size.

In Plate XXVI the deciduous dentitions of various three-toed horses are shown, of the natural size. Fig. 1 is probably *Protohippus pachyops* Cope; 2 is *P. perditus* Leidy, displaying two permanent and one deciduous molar; Fig. 2, external view, 2 *a* the crowns. Fig. *m.* i is the just protruded first true molar, and Fig. *d.* 4 is the fourth deciduous molar much worn. Fig. 3 represents an undetermined species, and Fig. 4 is referred provisionally to the *Protohippus insignis* Leidy. Fig. 5 represents three superior permanent molars of the *Protohippus medius* Cope, much worn.

The relations of these to the adult forms are discussed in a forthcoming bulletin of the Geological Survey of Texas, from which these plates are copied.—E. D. Cope.

Geological News.—Paleozoic.—A reptilian skull from the Karoo Beds, Cape Colony, has been referred by H. G. Seeley to a suborder, Gennetotheria, which lies midway between the typical Theriodonta and the Dicynodonta. The species, to which the name *Delphinognathus conocephalus* has been given, indicates a new family of fossil Reptilia distinct from the Ælurosauridæ, distinguished by the conical parietal with a large foramen, the supracondylar notch, and other modifications of the skull and teeth.—*Quart. Jour. Geol. Soc.*, 1892.——Mr. J. F. Whiteaves has published a paper on the Orthoceratidæ of the Trenton Limestone of the Winnipeg Basin in the Trans. Roy. Soc. Canada, 1891. It consists of a critical and systematic list of the Orthoceratidæ at present in the Mus. of the Geol. Survey of Canada, from the formation and region indicated by the title, together with descriptions of seven new species.——Messrs. Etheridge, Jr., and Mitchell are publishing a series of papers in the Proceeds. of the Linn. Soc. on the Silurian Trilobites of New South Wales. The first appears in Vol. vi, Part 3, and is devoted to the family of Proetidæ. Of the three members described, two, *P. rattei* and *P. australis*, are new.——A collection of fossils from the magnesian limestone of northeastern Iowa, described by S. Calvin, leaves little doubt as to the equivalency of that formation with the calciferous series of northeastern New York.—*Am. Geol.*, Sept., 1892.——Mr. N. H. Darton announces the discovery of organic remains of ordovician age in the so-called Archean rocks of central Piedmont, Va. The remains are crinoids, closely allied to *Schizocrinus*, *Heterocrinus*, and *Poterocrinus*. The exact position of the terrane in the ordovician is yet uncertain.—*Am. Jour. Sci.*, July, 1892.

Mesozoic.—British Cretaceous Foraminifera are receiving attention at the hands of various students. A monograph on the Foraminifera of the Gault by Chapman, published in the *Journal of the Microscopical Society*, is a most valuable reference work, as the author has treated the subject in an exhaustive manner. Another series of articles on the Foraminifera of the Trias, by Messrs. W. D. Crick and C. Davies Sherborn, appears in the *Journal of the Northamptonshire Natural History Society*.——According to Hyatt the Jura-Trias is well-developed about Taylorsville, California. The age of the Trias as indicated by its fossils is that of the Noric and Karnic series in the upper Trias. The lower, middle, and upper Jura are all represented in the fossil faunas of the region, and particularly in those of Mt. Jura, near the center of the area. A scarcity of vertebrate remains is a feature of this region in common with the entire column of the Trias and Jura along the western slopes of the Sierra Nevada and the Andes. (Bull. Geol. Soc. Am., Vol. iii.)——Prof. A. Gaudry announces the discovery of the snout of a Pythonomorph in the upper Cretaceous of Cardesse, not far from Pau, which must have been 10 metres long. The snout resembles that of *Mososaurus giganteus* of Maestricht, with considerable difference as to dentition. He names it *Liodon mosasauroides*.—*Revue Scientifique*, Aug., 1892.

Cenozoic.—The Proceeds. London Zool. Soc. for 1891 contains some interesting descriptions and plates of fossil birds by Mr. Lyddekker. These comprised a new Moa from New Zealand named provisionally *Pachyornis rothschildi*, which affords the writer tolerable evidence that the typical species of *Anomalopteryx* and *Pachyornis* were differentiated from a common ancestor; a large extinct stork, *Propelargus* (?) *edwardsii*, from the Allier Miocene, evidently very closely allied to genera still existing; and several species from the Sardinian and Corsican Islands——Two mammals, *Cervus pachygenys* and *Antilope maupasii*, have been added by M. A. Pomel to the list of those discovered by him in the Plistocene formations in Algeria.——Mr. Clement Reid intimates that during the Glacial Epoch there was throughout Central Europe a period of *dry* cold, causing that region to resemble the arid wastes of Central Asia. These desert conditions seem to have extended in a modified degree into the South of England. —*Natural Science*, Aug., 1892.

MINERALOGY AND PETROGRAPHY.[1]

The Geology of the Kaiserstuhlgebirge, by Graeff,[2] contains a resumé of the facts known concerning the structure of this celebrated region, and a brief synopsis of the characteristics of the interesting volcanic rocks occurring there. The tephrites, basanites, phonolites, limburgites, nephelinites and leucites found in dykes and flows in the mountains are described only briefly, as they are all well-known to petrographers. The loess, tufas and the crystallized limestone, the latter of which forms the central portion of the heights, are treated as briefly, except that in relation to the origin of the limestone the author enters upon a discussion to show that it is probably a metamorphosed Jurassic rock. The most interesting portion of the paper is that which describes the inclusions in the eruptives. These are gneiss, granite, eleolite-syenite, and fragments of the volcanic rocks. They have all been more or less altered by the eruptive in which they are imbedded. The wollastonite and melanite crystals, both very common in the phonolite, are thought to be the remnants of metamorphosed limestone fragments. The most striking inclusions are those found in a phonolite dyke near Obenbergen. They are often coarsely granular, and sometimes have rounded outlines. Their mineral constituents are the same as those of the including phonolite; but usually some one or more of them is completely lacking. Orthoclase, hauyne and nepheline are the most abundant components, and hauyne the most persistent, entire inclusions sometimes consisting almost wholly of large idiomorphic hauyne crystals. Graeff supposes them to be the cooled intratellurial portions of the magma, which on the surface yielded phonolite, that, after solidification, were brought to the surface by a second eruption of the same material. He believes the olivine bombs in basalts have an analogous origin, and that they are not simply concretions of the basic minerals of this rock.

A Cyanite-Garnet-Granulite from the Tirolese Alps.—This rock, obtained some time ago by Cathrein, has been examined microscopically by Ploner.[3] The garnet and cyanite are both in large

[1]Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2]Mitth. der Gross Badischen Geol., Landesanst 2, xiv, p. 405.

[3]Min. u. Petrog., Mitth. xii, p. 313.

grains, the former in dodecahedral crystals that have in many instances been shattered by pressure, and the latter in bent plates with the usual features of cyanite. Biotite encircles both of these minerals, notably the garnet, as a sort of zone. The groundmass in which these components lie is an aggregate of oligoclase, orthoclase and quartz, sometimes the monoclinic and at other times the triclinic feldspar predominating. Rutile is present in the rock as inclusions in the garnet, the cyanite and the biotite, as an alteration product of the mica, and as crystals in the quartz-feldspar aggregate. Muscovite, ilmenite, zircon and leucoxene are also present in small quantities.

Tufaceous Slates from Wales.—Among the sedimentary roofing slates of North Wales Hutchings[4] finds some that appear to be composed principally of andesitic and rhyolitic ash, consisting of fragments of lapilli, of feldspar and of sedimentary rocks imbedded in a paste of chlorite, small rods of sericite and minute grains of garnet, besides a little quartz and calcite. The most essential differences between these slates and those of sedimentary origin are with respect to their titanium constituents; in the ashes sphene and anatase being the most important, and in the true slates the so-called "slate-needles." These latter are thought by the author to occur only as decomposition products of biotite, and to be limited in their occurrence to water deposited fragmentals. The feldspar in the rocks under discussion are changed to white mica, chlorite and calcite. Secondary orthoclase and plagioclase often coat tiny cavities in the rock.

Alteration Products of Diabase from Friedensdorf.—The clefts in the diabase of Friedensdorf, near Marburg, are covered with little crystals of albite, analcite, natrolite, prehnite and calcite, all of which minerals occur also in the body of the rock. According to Brauns[5] they are decomposition products of the diabase plagioclase, and are due to the action of water containing carbon-dioxide upon this feldspar. Microscopic sections show the original plagioclase surrounded by fresh albite and filled with little nests of the other secondary substances mentioned. The process of the alteration is outlined by the author, who also shows the chemical relations existing between the new substances and the material from which they were derived. The diabase originally contained in addition to the plagioclase, both monoclinic and orthorhombic pyroxenes, olivine and titanic magnetite.

[4]Geol. Magazine, 3, ix, 1892, pp. 145–335.

[5]Neues. Jahrb. f. Min., etc., 1892, ii, p. 1.

The olivine and the orthorhombic pyroxene are serpentinized and the plagioclase altered as already indicated.

Camptonite Dykes in Maine.—In the gneiss of Androscoggin County, Maine, especially in the vicinity of Lewiston and Auburn, are a number of small dykes, some of which are of normal diabase, while others consist of camptonites. Olivine is abundant in several of the latter, and in such large grains as to be readily detected in the hand specimen. Olivine and augite are frequently in phenocrysts, while the last named mineral, hornblende and plagioclase make up the large part of the groundmass of the lamprophyres. An analysis of material from one of the dykes yielded Merrill and Packard:[6]

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5	CO_2	H_2O
39.32	1.70	14.48	2.01	8.73	.71	8.30	11.11	.87	3.76	.61	5.25	2.57

Predazzites and Pencatites.—Twenty specimens of predazzites and pencatites from various localities have been examined by Lenecek[7] in order to determine whether the rocks contain brucite or not. The sections of the true predazzites were found to have a calcite groundmass, scattered through which are fibres of hydromagnesite, supposed to be pseudomorphs after periclase, since cross sections of groups of fibres have a regular outline, and since one section of pencatite from Canzacoli shows periclase crystals more or less changed to serpentine. The dark pencatites differ from the predazzites in containing a large quantity of marcasite, to whose opacity the dark color of the rock is due. Besides the constituents already mentioned there are in both rocks many small grains of colorless silicates that may be pyroxenes, amphibole and olivine. Serpentine veins also cut both rocks, and brucite plates are not uncommon as the lining of little cracks.

Petrographical News.—Around the granite boss of Cima d'Asta, as around the other eruptive masses of eastern South Tyrol, there are abundant evidences of contact action in the contiguous sedimentaries, the contact rocks being not different in their essential characteristics from those surrounding the Adamello tonalite. The tonalite gneiss of the Adamello region is a pressure gneiss, occurring along lines, which were the slipping directions in the eruptive.[8]

[6]Am. Geol., x, 1892, p. 49.
[7]Min. u. Petrog. Mitth., xii, p. 429.
[8]Sdlomon. Min. u. Petrog., Mitth. xii, p. 408.

At last Rosenbusch[9] has replied to Michel Levy's criticism of his classification of massive rocks. In this reply the author first corrects some misstatements made in Levy's brochure, and then discusses the questions of priority which the French savant raises. After effectually disposing of these points Rosenbusch gives the reasons that led him to suggest the separation of massive rocks into the three classes, the plutonic, the volcanic, and the dyke rocks, and states that the recent work of all petrographers has strengthened his determination to hold to this classification.

The granite, porphyry, schist and clastic rock boulders occurring in the various conglomerates aud breccias of the "Flysch" in Switzerland have been thoroughly studied by Sarasin,[10] who recognizes among them many that are identical in substance with rocks in the Southern Alps. This fact leads him to suggest that the middle Alps were not elevated to anything like their present height at the time when the conglomerates and breccias were formed, but that there was then an unimpeded course from the Southern Alps to the northern side of the Northern Alpine ranges.

In an article entitled The Geology of the Massive Rocks of the Island of Cyprus, Bergeat[11] describes with very little detail diabase, gabbro, wehrlite, serpentine, andesite, liparite, trachyte, and andesitic and liparitic tufas, all of which occur in some quantity on the Island. All are very much altered.

In a block that fell from the walls of the Legbachthal, Oberpinzgau, in the central Alps, Weinschenk[12] found a small dyke of much altered kersantite. On the contact of the dyke with the intruded biotite feldspar schist the latter is changed to an aggregate of epidote, quartz, feldspar and muscovite.

Hibsch[13] describes from Southern Paraguay a sandstone, a quartz porphyry and a nepheline-basalt.

Josephinite, a New Nickel-Iron Alloy.—*Josephinite*[14] occurs as magnetic pebbles in the placer gravel of a stream in Josephine and Jackson Counties, Oregon. The pebbles consist of a greenish-black siliceous substance intermingled with grayish-white areas of the alloy.

[9]Ib., xii, p. 351.
[10]Neues. Jahrb. f. Min., etc., B. B. viii, p. 180.
[11]Min. u. Petrog., Mitth. xii, p. 263.
[12]Min. u. Petrog., Mitth. xii, p. 328.
[13]Ib., xii, p. 253.
[14]Amer. Jour. Sci., June, 1892, p. 509.

The siliceous matter is partly serpentine and partly a silicate, insoluble in acid, possibly an impure bronzite. The alloy has a composition corresponding to $Fe_2 Ni_5$. Chromite, magnetite and troilite are also present in the pebbles, the first two as granules in the silicates. The alloy is gray, malleable and sectile, and has a hardness of 5. Its origin is probably terrestrial.

Crystallography.—On crystals of *vesuvianite* from the blocks of Monte Somma, Boecker[15] finds seven new forms and recognizes a tabular type hitherto undescribed. The new forms detected are $\frac{1}{6}P\infty$, $\frac{2}{9}P$, $\frac{5}{2}P$, $\frac{5}{14}P$, $\frac{5}{18}P\frac{5}{18}$, $\frac{2}{7}P\frac{2}{7}$, and $\frac{11}{4}P\frac{11}{4}$. He describes also transparent green crystals of the same substance implanted in granular yellowish-green vesuvianite from Lermatt.

On *topaz* from near Miass in the Ilmen Mountains, S. Urals, Souheur[16] reports a large number of new planes in the prismatic and the pyramidal zones, and that between $P\bar{\infty}$ and $\frac{1}{2}P$. The crystals are from Redikorzew's topaz mine, where they are associated with ilmenorutile, black tourmaline, and muscovite on an amazonite-bearing granite.

The plane $P\breve{2}$ has been discovered by Pelikan[17] in *sulphur* crystals, implanted on antimonite from Allchar, Macedonia. Measurements of cleavage pieces of meteoric iron incline Linck[18] to the belief that the twinning of the iron is parallel to the plane 2O2.

Mineralogical Notes.—Another calculation of the formula of *tourmaline* from published analyses leads to the suggestion by Kenngott[18] that the various members of the tourmaline group are isomorphous mixtures of the compounds $3R_2O. SiO_2 + 5 (R_2O_3. SiO_2)$ and $2 (3RO. SiO_2) + R_2O_3. SiO_2$. The red tourmaline from Rumford, Me., may be regarded as the first end member of the series. The last end member is not yet known.

New analyses of *pseudobrookite*[19] from the Siebenbürgen yield no magnesia. Crystals from this locality, like those from Norway, thus consist simply of iron and titanium oxides. They are tabular with $\infty P\bar{\infty}$, $\infty P\breve{\infty}$, $\infty P\bar{2}$, ∞P, $P\bar{\infty}$, $\frac{1}{3}P\breve{\infty}$ and $\frac{7}{2}P$, of which the latter is

[15]Zeits. f. Kryst., xx, p. 225.

[16]Zeits. f. Kryst., xx, 1892, p. 232.

[17]Min. u. Petrog., Mitth., xii, p. 344.

[17]Zeits. f. Kryst., xx, p. 209.

[18]Neues. Jahrb. f. Min., etc., 1892, ii, p. 44.

[19]Traube. Zeits. f. Kryst., xx, 1892, p. 327.

PLATE XXVI.

Dentition of three-toed colts.

new. Their axial ratio is .98123 : 1 : 1.12679. The mineral is found in clefts of an andesite, or in the rock mass in the neighborhood of inclusions of quartz and augite.

In his Notes on Some Minerals of the Fichtelgebirge, Sandberger[20] gives analyses of *titanic iron* sand from the banks of the Eger, of *rhodonite* from Arzberg, of the *margarodite* covering orthoclase crystals in the druses of the lithionite granite of Epprechtstein, of the *chlorite* pseudomorphs of orthoclase crystals in the dolomite of Strehlenberg, and of a *lithium mica* from Fröstau, near Wunsiedel. The last named mineral is one of the constituents of a rock whose only other original component is white albite. Its analysis gave:

SiO_2	F	Al_2O_3	Fe_2O_3	MnO	MgO	K_2O	Na_2O	Li_2O	H_2O
50.11	1.36	1.36	1.01	1.01	.96	10.51	1.58	1.43	1.91

besides small amounts of TiO_2, SnO_2, FeO, CaO, CuO, As, Sb, Pb, Co, and B. The author thinks that there are certainly five distinct lithium micas known.

Katzer[21] mentions the occurrence of *arsenopyrite* and *quartz* crystals at Petrowitz, in Bohemia, of *sphalerite* and other sulphides, and of *siderite* at Heraletz, of *wollastonite* in fibrous masses on the contact of limestone with granite-gneiss, and of crystals of blue *cordierite* at Humpoletz, of andalusite at Cejod, of a calciferous *tourmaline* at Benitz, and of *gypsum* crystals at several localities in the same Kingdom. The tourmaline analyses gave:

SiO_2	Al_2O_3	B_2O_3	FeO	Fe_2O_3	MnO	CaO	MgO	Na_2O	K_2O	F	H_2O
35.53	30.73	5.59	5.67	7.67	1.17	3.16	2.82	4.38	.63	.12	2.86

Crystals of *epsomite* are described by Milch[22] from Stassfurt-Leopoldshall, Germany. They are implanted on a granular halite or a saliferous clay, and reach in many cases several centimeters in dimensions. They are all columnar in habit, and are remarkable for their richness in planes and for the marked character of their hemihedrism. The principal forms occurring in them are $\infty P\bar{\infty}$, $\infty P\breve{\infty}$, ∞P, $\infty P\bar{2}$, $\infty P\breve{2}$, $P\bar{\infty}$, and $2P\bar{\infty}$.

Several rough, twinned crystals of *alabandite* from a deposit of the mineral in the Lucky Cuss Mine, Tombstone, Arizona, have been anal-

[20]Neues. Jahrb., f. Min., etc., 1892, ii, p. 37.

[21]Min. u. Petrog., Mitth, xii, p. 416.

[22]Zeits. f. Kryst., xx, p. 221.

yzed by Messrs. Moses and Luquer.[23] The mineral is of a dark, lead-gray color, with a brownish tarnish. *Wavellite* from the Dunellen Phosphate Mine, Marion Co., Fla., contains $Al_2O_3 = 37.076\%$, $P_2O_5 = 33.887\%$, and $H_2O = 26.366\%$.

Zincite crystals from Sterling, N. J., have again been analyzed. Grosser[24] finds in them $ZnO = 96.20$; $MnO = 6.33$; $Fe_2O_3 = .43$.

New Instruments.—A new signal for use in goniometrical measurements has been introduced to the notice of crystallographers by Goldschmidt,[25] which, it is believed, has several advantages over the Websky signal. A new adjusting apparatus for the goniometer has also been devised by the same crystallographer. It consists of an arm movable in four or five directions. By its use all the zones in a small crystal may be measured without the necessity of imbedding the crystal in wax more than once. A cheap heating apparatus to be used with the microscope has been constructed by Schrauf.[26] It is essentially a little box of a non-inflammable, poorly conducting material that is heated directly by a gas burner.

Staske[27] uses a very simple instrument for the production of curves of heat conductivity on mineral plates. It comprises a copper wire heated at one end and at the other touching the mineral slice, coated with paraffine.

Miscellaneous Notes.—Another investigation to determine the solubility of minerals in water under pressure, in the presence and absence of carbon-dioxide, has been made by Binder.[28] He finds that at 90° *bornite, chalcocite, marcasite, manganite* and *fluorite* are dissolved to an appreciable extent in pure water, and *cinnabar, cuprite,* and *pleonaste* to a slight degree only. When CO_2 is added to the solvent, *pyromorphite* dissolves, and *epidote* in small amounts. Under the same conditions *andalusite* and *anorthite* are decomposed.

The U. S. National Museum has issued a handbook of Geognosy, dealing with the materials forming the earth's crust. In it Mr. Merrill[29] outlines the characteristics of the aqueous, æolian, metamorphic

[23]School of Mines Quarterly, No. 3, xiii, p. 237.

[24]Zeits. f. Kryst., 1892, xx, p. 354.

[25]Zeits. f. Kryst., xx, 1892, p. 344.

[26]Ib., xx, 1892, p. 363.

[27]Ib., xx, p. 216.

[28]Min. u. Petrog., Mitth. xii, p. 332

[29]Rep. of Nat. Mus. for 1890, p. 503.

and igneous rocks, and then describes briefly the principal members of each class. The little book is well illustrated, and its contents are conveniently arranged for the student of the museum's collections.

All of the natural manganese oxides except pyrolusite and manganite yield red or violet solutions when digested with a mixture of sulphuric acid and water in equal proportions.[30]

[30] Thaddeef. Zeits. f. Kryst., xx, 1892, p. 348.

BOTANY.

The Development of the Ovule of Aster and Solidago.—The following is from an unpublished paper on The Development of Flower and Embryo-sac in Aster and Solidago, by Dr. George W. Martin. The work was done in the botanical department of the Indiana University in the year 1891–2:

A short time before the floral organs attain their maximum length there appears at the bottom of the ovarian cavity a rounded excrescence; this is the incipient ovule, the promise of a future seed. This incipient ovule does not arise from the bottom of the ovarian cavity, but a little above the lowest point. Therefore, the ovule is not the terminal structure on the floral axis, for, by careful focusing, the apex of the fascicular system is seen to end very abruptly at the bottom of the ovary cell. To the right and left of the axial bundle of the pedicel, a little below the apex, are given off fibro-vascular bundles which traverse both sides of the capellary leaf. It is in the region of one of these lateral bundles, beneath the epidermis, where arise the primitive cells that arch upward and give rise to the funiculus and the nuclear ovule. Subsequently a branch of this lateral bundle enters the funiculus.

At first the ovule consists of a mass of cells, the tissue of which is soft and cellular, and is designated the nucleus of the ovule or the nucellus. By further development a large nucleated cell appears within this nucellar tissue, which soon divides, the apical cell of which becomes the mother-cell of the embryo-sac. In its early development the nucellar body is almost orthotropous, but by further growth it becomes curved (caused by a stronger growth on one side) at the point (base of the nucellus), where the integument originates. At first the integument appears as an annular ring; as growth takes place it forms a complete wall around the nucellus; as the wall encroaches upon the apical portion of the nucellus the latter becomes more and more curved, but does not seem to be wholly inverted until the integument completely surmounts it, even passing far beyond the nucellar apex. Thus, we have an ovule which is anatropous, having a single integument, though very thick and forming the greater mass of the ovule before fertilization is accomplished, investing a small central portion, the nucellus; and the latter, which consists of but one layer of cells, in turn surrounds a more central portion, the embryo-sac. Originally

this sac consists of but a single nucleated cell, which, when division is complete, forms a central row of cells. The nucellus in process of growth becomes very much elongated; its cells are well defined and nucleated; likewise the mother-cell of the embryo-sac, though primitively polyhedral in outline, but later more oval in contour, elongates and contains a nucleus with nucleolus, imbedded in a rich mass of protoplasm. In some sections the nucleus appeared to be elongated in the same direction as the embryo-sac.

During the subsequent growth of the integument and the nucellus, the embryonal sac enlarges, and the nucleus of the mother-cell undergoes sub-division. In a specimen seen the nucleus had divided, and the mother-cell afterward separated into two equal parts by a transverse wall, each part containing a nucleated cell. Presently the two nuclei divide, a transverse wall is formed in each half, and thus we have, at the end of the second and last sub-division of the mother-cell of the embryo-sac, four equal, nucleated cells. At this stage of the embryo-sac there is a very close analogy to the division of the mother-cell into four cells worked out by Strasburger in Polygonum and Senecio. The cross walls formed between the cells are very strongly refractive and much swollen; the middle transverse wall is remarkably distended, and persists much longer than the other two partitions; in several sections the middle wall was found intact when the contents of the cells were completely absorbed. Of the four cells into which the primitive mother cell of the embryonal sac is now divided only the lower one is characterized by further growth; this cell, therefore, becomes the true mother-cell of the embryo-sac. Subsequently the protoplasm of the upper three cells becomes viscid, the nuclei show disintegration, and the upper wall of the lower, club-shaped cell (mother-cell) indicates a rigid turgescence. When the upper three cells begin to disorganize (in centrifugal order), they become crescent-shaped, their nuclei disappear, their walls are displaced, and the cell contents are absorbed by the encroachment of the lower mother-cell. After the cells are completely disorganized and absorbed the mother-cell assumes a central position in the embryo-sac.

Simultaneously with the obliteration of the upper cells of the embryo-sac the one-cell-layer of the nucellus undergoes a similar process of disintegration. The first mark of displacement is shown by the reduction of the cell contents to a granular mass of protoplasm; then follows the disappearance of the transverse cell walls. The order of nucellar displacement begins at the apical end of the nucellus and proceeds towards its basal portion; finally the whole nucellar tissue is

displaced and absorbed by the embryo-sac, which subsequently becomes very much enlarged. Sections were made showing a partial obliteration of the nucellus, and at this period of growth the embryo-sac is completely filled with protoplasm, in the central portion of which is located the mother-cell, with a vacuole both above and below it. Later sections showed a complete displacement of the nucellus, an elongation of the embryo-sac, a further separation of the vacuoles, the first division of the mother-cell into two daughter cells, each moving, the one to the upper the other into the lower end of the embryo-sac. In the next stage of development we have the first division of the polar nuclei, thus making two nuclei in each end of the embryo-sac. The two upper nuclei rest within an accumulation of protoplasmic substance, while the two lower nuclei rest within a less dense plasma between an upper and a lower vacuole which show a longitudinal expansion. Previous to the last division of the polar nuclei a longitudinal increase of the whole embryo-sac takes place. Subsequently each of the two nuclei divides, and we have four nuclei occupying opposite extremities of the embryo-sac. Thus, division is complete, and the upper cells give rise to the egg-apparatus, while the lower are designated antipodal cells. The next stage of development is characterized by the ascent of one of the antipodal cells toward the center of the embryo-sac. This nucleus is imbedded in a dense mass of protoplasmic material separating two large vacuoles. Of the three antipodal cells remaining, the two upper of which lie alongside and impinge on each other, also rest in a plasma bridge separating two vacuoles, the upper of which is the larger, and the lower one of the two previously mentioned vacuoles. The lowermost cell is partly obscured by the impingement of the lowermost vacuole.

At the micropylar end of the embryo-sac the cells have a far different significance. One of the cells in its descent toward the center of the sac meets its fellow from below and both coalesce, thus forming the secondary or endosperm nucleus. The three remaining cells, though naked like the three opposite, but surrounded by a dense mass of protoplasm, constitute the true egg-apparatus. The two upper cells of the egg-apparatus, which lie side by side, occupying the whole tapering anterior end of the embryo-sac, are the synergidæ; at their lower extremity, occupying nearly the whole width of the sac, lies a large rounded cell, the oosphere.

In further development the embryo-sac becomes very much swollen, which is a characteristic feature both before and after the process of fertilization. But fertilization in this case has not yet been accom-

plished, as the perfectness of outline of the synergidæ amply testify. The upper vacuole shows a contraction toward the upper extremity of the embryonal sac, and is more oval in outline. At this stage, also, the upper polar nucleus exhibits retarded action in its descent toward its counterpart from below, even in many cases refusing descent until after or about the fertilization period.

Botanical Teachers and Text-Books.—At its best, the botanical text-book is a necessary evil. One student and one teacher is the ideal college. The time-worn epigram of Garfield about Mark Hopkins and the log contains the gist of the matter. But where the class-system is necessary our few great teachers are brought into contact with the multitude of learners by means of the text-books. A man's personality is, however, rarely caught in print. The peculiar charm of his presence and the inspiration of his own living enthusiasm is lost, while, in its stead, there may be but a dry collection of ex-cathedra facts and generalizations. Therefore, one must supplement the cold repast with something appetizing and warm of one's own, if one has anything of one's own to offer. And in this connection it may be well to emphasize the necessity of interest and intelligence on the part of the teacher. Of course, an uninterested teacher is forever an uninteresting teacher. A teacher who is content with "hearing the lesson" is an enemy of education. The idea which some have that the text-book is the teacher and that the individual by courtesy named "teacher," or sometimes "professor," is merely a kind of intellectual galvanometer which indicates by a series of figures running from one to ten whether the electric current of information from text-book to pupil is relatively strong or weak; this idea, be it respectfully said, is so ingeniously perverted that it quite commands our admiration. Deliver us from botanical teachers who hear the lessons.—CONWAY MACMILLAN, in *Education.*

ZOOLOGY.

Thelohan on Coccidia.[1]—Thélohan describes a curious Coccidium (*C. cruciatum*) parasitic in the liver of *Caranx trachurus.* The four spores are arranged in the form of a cross and the envelope of each spore is formed by two valves, which is an entirely new departure for this genus. A *Coccidium* species (?) found in the livers of sardines and herrings was similar to *C. cruciatum* except that the cross arrangement of the spores was not noticed in any case. *C. minutum,* a new species from the tench, is also described.

It has been proven that the species of Coccidium which infest rabbits run through their spore stage after escaping from their hosts, but Thélohan has discovered the interesting fact that the new species which are here described, as well as *C. sardinæ* Th. and *C. gasterostei* Th. form their spores and sporozoites while still inside their host. With this change of habit the thick membrane of other species becomes unnecessary and in the species found in fish the membrane is in reality very thin. *C. bigeminum* of dogs lies between these two extremes, for the sporoblasts form while the parasite is still in the dog, but the sporozoites evidently do not form until the parasites escape from their host.

In the same publication Thélohan describes "Des Sporoziaries Indéterminés Parasites des Poissons (pp. 162–170)," which are very difficult to classify in the present system. They resemble *Eimeria,* but according to Thélohan the cyst contains a true nucleus as well as sporozoites.

It will be remembered that certain German authors now wish to suppress *Eimeria,* since they believe that genus simply forms a stage in the development of *Coccidium* by "gymnospores (Pfeiffer)." Should this theory be definitely established (contrary to Pfeiffer and others, we cannot consider it *as yet* definitely proven that *Eimeria* is identical with the gymnospore stage of *C. oviformes*), the "Sporozoaires indéterminés" of Thélohan might bear the same relation to the fish coccidia that *Eimeria,* according to certain German authors, bears to the coccidia found in rabbits.—C. W. S.

Recent Work on Parasites.—Dr. C. W. Stiles, of the Bureau of Animal Industry, has recently published several articles on para-

[1]P. Thélohan, sur Quelques Coccidies Nouvelles Parasites des Poissons. Jour. de l'Anat. et de la Phisiol., 1892, pp. 152–171, Plate 12, 1–32.

sites which may be of interest to the readers of THE NATURALIST, as most of the articles are upon American species.

Under the title Bau und Entwicklungsgeschichte von Pentastomum Proboscideum R. und P. Subcylindricum Dies (Z. f., w. Z., 1891, lii, pp. 85–157. Taf. vii–viii, Figs. 1–49), he gives an account of the microscopical anatomy and histology of the American *Pentastomum* (more correctly *Porocephalus*) *proboscideum*, found in the lungs of American snakes. He succeeded in infecting white mice with the embryos, and in this way raised *P. subcylindricum*, which had been supposed to be a separate species. The paper covers an historical review, synonomy, list of hosts; ten snakes for the adult form, ten mammals for the larva; geographical distribution, structure of the embryo; description of five stages in the development; bibliography of the order Linguatula.

It is impossible to enter into a detailed account of the results in this short review; suffice it to say that in the embryo he has found a well-developed nervous system, intestine, etc.; he denies that the boring apparatus of the embryo consists of rudimentary mouth-parts. In the first part of his paper he is evidently in doubt as to the homology of the four hooks found in the adult, but from his later statements he evidently believes them to be homologous with the mouth-parts rather than with the third and fourth pairs of legs of other arachnoids, as is now the generally accepted view (Claus).

Sur la Biologie des Linguatules (Compt. Rend. d. l. Soc. d. Biol., Paris, 1891, pp. 348–353) is a discussion of the various theories in regard to the wanderings of Linguatula and *Porocephalus* (*Pentastomum*).

Under the title, Notes on Parasites, Stiles is publishing a series of short informal articles upon observations on various parasites. Each article is numbered according as it is finished.

1. Sur la dent des Embryons d'Ascaris (Bull. d. l. Soc. Zool. d. France, 1891, pp. 163–164) has already been reviewed in this journal.

2. *Jour. Comp. Med. and Vet. Arch.*, 1892, pp. 517–526, twelve figs., gives a fuller description and figures of the parasites. Stiles mentioned in his Note Préliminaire sur Quelques Parasites (Bull. d. l. Soc. Zool. d. France, 1891, pp. 163–165), *Coccidium bigeminum*, a new species of sporozoa found in the intestinal villi of dogs; *Dispharagus gasterostei*, Stiles, 1891, the only member of the genus as yet found in fish; *Mermis crassa* v. L., which the author found escaping from larvæ of *Chironomus plumosus*.

3. On the intermediate host of *Echinorhynchus gigas* in America (Zool. Anzeiger) has been reviewed in THE NATURALIST.

4. *Myzomymus scutatus* (Müller) Stiles, 1892. (*Jour. Comp. Med. and Vet. Archiv.*, pp. 65–67, Fig. 1). In this article, which is a preliminary note on a species originally placed by Müller in another genus, the author describes a very common parasite infesting the œsophagus of American cattle. In No. 12 a complete description with figures is given.

5. A word in regard to the *Filaridæ* found in the body cavity of horses and cattle. (*Jour. of Comp. Med. and Vet. Archiv.*, 1892, pp. 143–146, Fig. 1). The author gives new diagnosis for the two species; describes four new sense papillæ on the head and a fifth pair of post-anal papillæ in *F. cervina;* introduces the term ad-anal to denote the fourth pair of pre-anal papillæ in this species of other authors; shows that the dorsal and ventral oral spines in the female of *F. cervina* are distinctly paired, while in the male of *Cervina* the pairing is indistinct; in both male and female of *F. equina* they are generally single, although occasionally a slight pairing was noticed.

6. On the presence of *Strongylus ostertagi* (Ostertag, 1890) Stiles, 1892, in America (*Jour. Comp. Med. and Vet. Archiv.*, 1892, pp. 147–148). The author mentions that the parasite, found in the rumen of cattle and sheep and known by German authors under the name of *Strongylus convolutus*, is found in this country. The specific name being preoccupied in the genus *Strongylus* Stiles, changes the name to *Ostertagi.*

7. A word in regard to Dr. Francis' *Distomum texanicum* (*Am. Vet. Rev.*, 1892, pp. 732–733). The author states that *Distomum texanicum* is identical with *Fasciola carnosa* seu F. Americana Hassall, '91, and probably identical with *D. magnum* Bassi, 1875.

8. A check list of the animal parasites of cattle (*Jour. of Comp. Med. and Vet. Archiv.*, 1892, pp. 346–350). The author gives a list of parasites found up to date in cattle.

9. Two cases of *Echinococcus multilocularis* in cattle (*Jour. Comp. Med. and Vet. Archiv.*, 1892, p. 350). The first case of *Echinococcus multilocularis* in this country in cattle is here recorded.

10. A case of intestinal coccidiosis in sheep (*The Jour. of Comp. Med. and Vet. Archiv.*, 1892, pp. 319–328, Figs. 1–14). The author describes and figures a case of *Coccidium perforans* in sheep found by Dr. Cooper Curtice. He discusses at length the new nomenclature of Sporozoa used by Wolters and Pfeiffer, and comes to the conclusion that it is not only very inappropriate but illogical and unzoological. He compares in a tabulated form the various stages of development with the corresponding stages of lower plants. The last column of

the table contains the technical terms which are most appropriate and which should be accepted.

11. *Distoma magnum* Bassi, 1875 (*Jour. of Comp. Med. and Vet. Archiv.*, 1892, pp. 464–466). Author states that he has compared specimens of *D. texanicum* Francis, *Fasciola americana* Hassall, and *Distomum magnum* Bassi, and finds them to be the same species. In a postscript he replies to a personal attack by Dr. Francis.

12. On the anatomy of *Myzomimus scutatus* (Mueller, '69) Stiles 1892 (Leuckart's Festschrift, 10 pp., with 1 plate, 29 figures). Minute description of microscopical anatomy of *Myzomimus scutatus*, found in the horse, cattle, sheep, and pig. The description of the embryo and its mode of progression is especially interesting.

13. *Tænia giardi* (Riv.) Moniez. (Bull. Soc. de. Biol., Paris, 1892, pp. 664–665). Some authors have described the genital pores as being double in this species. Whilst this is sometimes the case, the author shows that it is comparatively rare. The testicles are usually grouped on the side of the segment, but occasionally stray testicles are found in the median field. It is not infrequent to find fully developed female genital organs on one side of the segment and rudimentary ones on the other.

14. Sur le *Tænia expansa* Rudolphi. (Comp. Rend. d. l. Soc. d. Biol., 1892, No. 27, pp. 664–666).

Author describes a new organ that he has found in nearly all species of Monizia he has examined. This organ which he calls the *interproglottidal gland*, is situated at the border between every two segments. In specimens of the type of *Moniezia planissima* n. sp., St. and H., this organ is linear in form, extending nearly from side to side. In the *Expansa type* these glands are found extending nearly across the whole of the segment but are not linear, a large number of glandular cells converging toward a blind sac, the sacs opening on the posterior border of the segment beneath the overlapping flap of the anterior segment.—ALBERT HASSALL, Washington, D. C.

New Fishes from Western Canada.—*Coregonus coulterii*, E. and G.—Types: Over one hundred specimens, Kicking Horse River, Field, B. C.

At an elevation of 4050 feet in the Rockies, just beyond the continental divide on the Canadian Pacific Railroad, I procured a species of *Coregonus*. *Coregonus williamsonii* is found about twenty-five miles to the east of Field at an elevation of 4500 feet in a tributary of the Saskatchewan. It is also found in the Columbia at an elevation

of 2550 feet at the mouth of the Kicking Horse, and again to the south in the headwaters of the Missouri. No specimens of *williamsoni* were noticed at Field, and the species obtained there is very different from *williamsonii*. The species found at Field is closely related to *C. kennicotti*, but has much larger scales.

Head, 4½–5; depth, 4½–5½; D., 10½–11½; S., 12–13; scales, 7-60 to 63-7. Form rather heavy, little elevated; the snout broad, very blunt and decurved; greatest depth of head equals its length less the opercle. Mouth low, the snout but little projecting, maxillary reaching eye in larger specimen, further in the smaller ones. Eye equals snout, 4-inch head; supplemental bone a crescent; gill rakers much as in *williamsoni*; scales large, dull silvery.

Named in honor of Rev. J. M. Coulter, author of the Manual of the Botany of the Rocky Mountain Region.

The Darters of Canada.—Hitherto but a single species of Etheostoma has been known from British America. *E. boreale* was taken by Jordan at Montreal. Last summer I obtained several species in western Canada, which may be mentioned in advance of my general report on my summer's explorations.

2. *E. aspro* (Cope and Jordan). Winnipeg and Brandon.

3. *E. güntheri* E. and E. I procured three specimens of this species at Winnipeg. I have also discovered three specimens in the collections of the Indiana University taken by Prof. Meek near Cedar Rapids, Iowa.

Diagnosis.—Premaxillaries not protractile; gill membrane scarcely connected; ventral line with the median scales enlarged; lateral line complete; palate with well-developed teeth; preopercle entire; nape and breast (with the exception of the median line) naked; cheeks and opercles each with about three series of large scales. Head, 3⅘; depth, 6⅓; dorsal, 10–13 or 14; anal 2, 9½–11½; scales, 5-52 to 54-5. Closely related to *E. aspro*.

4. *E. nigrum* Rafinesque. Specimens of this species were taken at Westbourne in a tributary of Lake Winnipeg, in the Assiniboine at Brandon, and it was found to be quite abundant in the Cu'Appelle River at Fort Cu'Appelle. I was assured both at Brandon and at Cu'Appelle that this species was abundant in some streams further north.

5. *E. iowæ* Jordan and Meek. This species was abundant in the Swift Current at the station of the same name.

6. *E. quappella* E. and E., is known from a single specimen from Cu'Appelle, the northernmost point from which darters are as yet certainly known. It is related to *E. iowæ* and to *E. jessiæ*.

Diagnosis.—Premaxillaries not protractile; gill membrane scarcely connected; ventral line with the median scales not enlarged; lateral line straight, developed on 19 scales; palate without teeth; anal fin considerably smaller than soft dorsal; humeral region without black process; cheeks with a few scales just below and behind eye; opercle with a few scales on its upper angle. Head, 4; depth, 5½; dorsal, IX–9; anal, 1, 6½; scales, 3-53–7.

7. *Cottus philonips* E. and E., nom. sp. nov.

Cottus minutus Pallas, Zoogr. Rosso. Asiat. iii, 145, 1811–1831.

Uranidea microstomus Lockington. Proc. U. S. Nat. Mus., 1880, 58; not *Cottus microstomus* Heckel.

The only companion of *Coregonus coulterii* in the snow water of the Kicking Horse at Field, B. C., was a species of *Cottus*, of which seventeen specimens were obtained. These are probably to be referred to the description quoted above. This species seems to be an inhabitant of the cold waters of Alaska and to extend along the Rocky Mountains and the Sierras to Lake Tahoe, where it is replaced by *Cottus beldingii*. Specimens of the latter species are not now at hand, so that a direct comparison can not be made.

Head proportionately longer in the adult, about 4¾–4 in head. D. VIII or IX–16 to 18; A. 11–13; V. 14. Pectoral reaching anal or past vent even in the largest specimens. Anus equi distant from tip of snout and base of caudal or nearer tip of snout. Ashy gray, with blackish blotches; no well defined cross bars except sometimes on the tail. Frequently a dusky blotch on anterior part of spinous dorsal and another near its posterior end; the fin sometimes wholly dusky, margined with white; pectorals soft, dorsal and caudal more or less barred.

5. *Cottus onychus* E. and E.

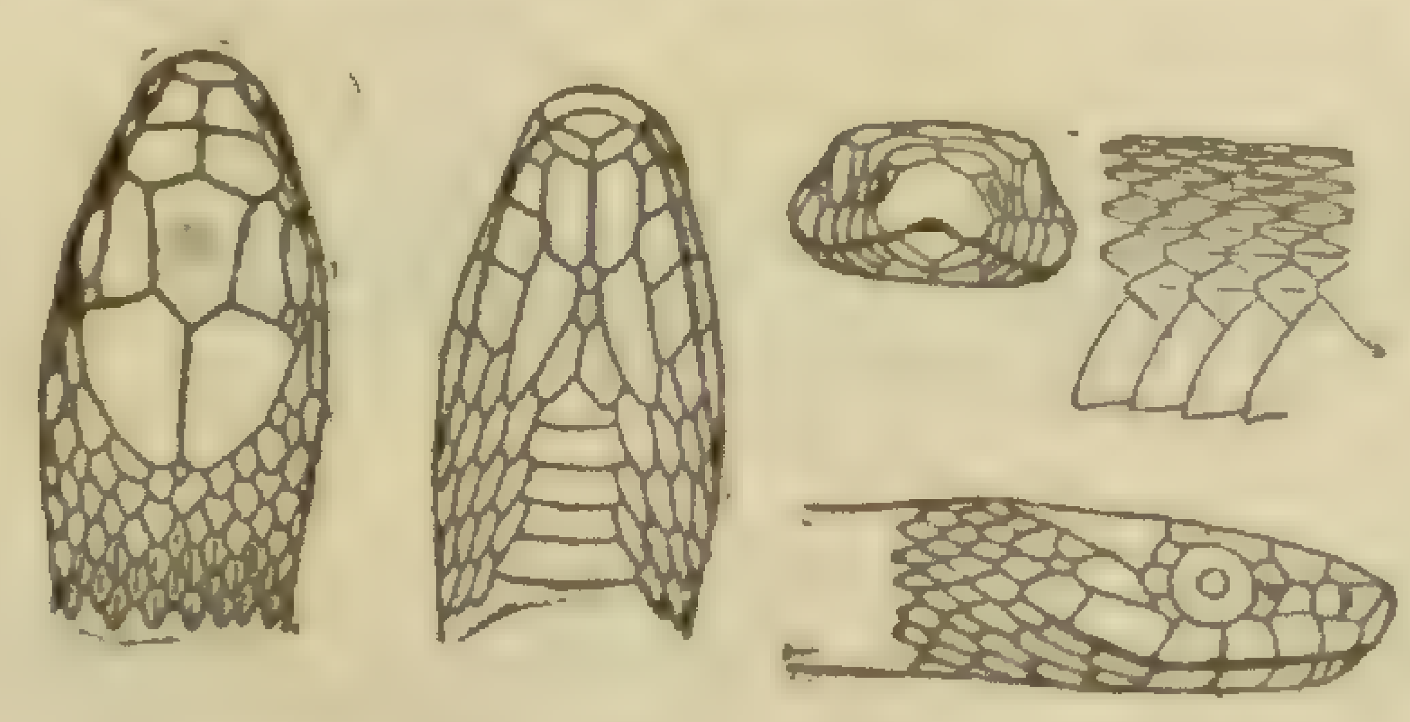
Type.—A single specimen 82 mm. long; Calgary.

This species is evidently closely related to *C. pollicaris* J. and G., from which it differs chiefly in having many prickles.

Head, 3⅔; depth, 6½; D. VIII, 17; A., 13; V., I, 4; P., 13. Teeth on vomer, none on palatines. Width of head equals its length to end of preopercular spine, its depth 2 in its length. Preopercle with an upturned claw-like spine, below which are two others much smaller, the anterior one having its point turned downward and forward. Eye 1⅓ in snout, ½ in interorbital, 4½ in head. Lower jaw projecting,

maxillary not reaching orbit. Sides above lateral line, which is complete, with stiff prickles from below the first dorsal spine to below the last ray; prickles below the lateral line more restricted. Dorsals connected by a low membrane, the soft rays much higher than the spines, 2 in head. Pectorals reaching past vent, the rays not branched. A median dusky spot on breast just behind anterior end of gill slits; ventral surface otherwise plain. Anal with a few dusky specks on its rays, other fins barred; sides and upper surfaces olive with darker spots. Three dark bands below soft dorsal; a narrow dark band just in front of the caudal.

A New Species of Eutænia from Western Pennsylvania.—A collection of alcoholic specimens from near Franklin, Venango County, Pennsylvania, on the Alleghany River, sent me by Miss Anna M. Brown, contains the following species: *Bufo lentiginosus americanus; Rana virescens virescens; Plethodon glutinosus*; *Plethodon cinereus dorsalis; Ophibolus doliatus triangulus;* and a Eutænia, which appears to represent a specific form which I have not previously seen. The single specimen is small, but not young, and it belongs to the group of which *E. sirtalis* and *E. leptocephala* are members. It resembles both these species, but differs in important particulars. The labial plates are six above and eight below, instead of seven above and ten below. The head is not distinct from the neck, resembling in this respect the genus Tropidoclonium. The parietal scuta are convex in outline, and not contracted posteriorly. The headplates are otherwise as in those species; including oculars, $\frac{1}{3}$; temporals, $\frac{1}{2}$; and post-geneials longer than pregeneials. Scales in nineteen series, all keeled



Eutænia brachystoma **Cope $\frac{3}{2}$ Natural Size.**

except the inferior row. Gastrosteges 132, anal 1, urosteges 72; color, below and upper lip light olive, unspotted; above darker olive, with a broad brown band on each side which extends from the fourth to the middle of the ninth row inclusive, leaving a pale dorsal stripe of ground color one and two half scales wide. Chin and anal plate yel-

lowish. No parietal pair of spots visible to the eye, but traces appear under a magnifier. Total length, 286 mm.; tail, 71 mm.

The reduction of the number of labial plates is effected both by the fusion of the fifth and sixth of the *E. sirtalis* and also by the abbreviation of the resulting plate, which, though longer than those adjacent to it, does not equal the two plates on the *E. sirtalis*, of which it is probably composed. The normality of the structure is confirmed by the reduction of the inferior labial series by two scales, all of which are of perfectly normal form. The gastrosteges are fewer in number than in any *E. sirtalis* or *E. leptocephala* known to me, while the number of urosteges remains as in those species. The absence of spots on the gastrosteges distinguishes it from most of the subspecies of *E. sirtalis*. The general form is that of Tropidoclonium, and the distinctness of the two nasal plates is the only feature which separates it from that genus. It is one of the forms of which several are now known, which, while retaining the general features of the water-snakes, have adopted a terrestrial life and more or less burrowing habits. I propose that this species be called *Eutænia brachystoma*.—E. D. Cope.

The Cervical Vertebræ of Monotremata.—In the number for January of The American Naturalist, Prof. J. Baur mentions (p. 72) the fact that the cervical vertebræ of the existing Monotremata have no zygapophyses, and that neither Flower in his Osteology of Mammals, nor Flower and Lydekker in their Introduction to the Study of Mammals, notice this peculiarity.

May I be allowed to draw your attention to the descriptive catalogue of the Osteological Series contained in the Museum of the Royal College of Surgeons, Vol. i, 1853, where Prof. R. Owen states, on Ornithorhynchus, p. 215: "The cervical vertebræ, which are seven in number and have no zygapophyses, and on Echida, p. 218, not any of the cervical vertebræ have zygapophyses save the atlas."

Leipsic. Prof. J. Victor Carus.

EMBRYOLOGY.[1]

Frog Embryos.—The surface views of early stages in the larval life of *Rana temporaria* presented by Friedrich Ziegler[2] form a pleasing contrast to many of the crude representations too often seen, even in important papers upon amphibian embryology. As life-like and accurate reproductions of the actual conditions observed, his figures of the blastopore, medullary folds, mouth, olfactory pits and adhesive disks merit the highest praise, and the method he resorted to seems destined to lead to much more satisfactory observations and drawing than could be expected from the methods in vogue. He simply inclines the microscope tube into a horizontal position and observes the frog spawn in a test tube placed beneath the stage, the illuminator and diaphragm being removed. A large condensing lens is also used to concentrate gas-light or sun-light upon the embryos. It is to be hoped the author will publish a complete series of such illustrations of the ontogeny of some frog.

Pineal Body in Amblystoma.—Immediately following the above article we find a short preliminary note by Albert C. Eycleshymer, of Ann Arbor, Mich. The presence in the embryo of two median dorsal outgrowths in the region of the pineal body is generally conceded, but their relative importance and ultimate fate are matters of uncertainty.

In amblystoma a crescentric evagination arises from the roof of the thalamencephalon when the larva is 5 mm. long; this is the epiphysis or posterior outgrowth. The presence of pigment in the inner ends of the cells and the behavior of their nuclei are strongly suggestive of phenomena seen in the optic vesicles. Much later, when the lens of the lateral eye is invaginating, a second median dorsal outgrowth arises from the posterior part of the roof of the prosencephalon. This is the paraphysis described by Selenka in reptiles. Subsequently both epiphysis and paraphysis undergo similar changes, but remain separate from one another.

The author considers the paraphysis of less importance than the epiphysis, but does not commit himself as to its probable nature. The epiphysis may have been of special use as a sense organ when the

[1]This department is edited by Dr. E. A. Andrews, Johns Hopkins University.

[2]Anatom. Anzeiger, vii. April, 1892.

medullary plate folded in and the lateral eyes were for a time of little use; the lateral eyes are actually present, as the author hopes to show, when the medullary groove first appears.

Polyspermy in Vertebrates.—Dr. J. Rückert[3] has advanced a most interesting explanation of the origin of the yolk-nuclei, parablast-nuclei or *merocyte nuclei* of meroblastic vertebrate ova. Finding these nuclei in eggs of elasmobranchs during, or even before, the union of the ♂ and ♀ pronuclei he was struck by their apparent identity with the male pronucleus. Later he found many sperms present before these yolk nuclei appeared, and also saw transition stages between the two. That this apparent origin of yolk nuclei from sperms may have been exceptional, abnormal, in the few cases observed becomes less probable when the very similar discoveries of Oppel in reptiles are considered.

Oppel[4] observed numerous secondary sperm-nuclei in the eggs of *Anguis fragilis* even before the union of the primary male pronucleus with the female pronucleus, and found them common in eggs of *Lacerta viridis* and *Tropidonotus natrix* also, at the time of union of these chief nuclei. These secondary sperm-nuclei often lie beneath funnel-shaped depressions of the surface of the blastoderm; they form no connection with the female pronucleus, yet undergo division, but soon degenerate and take no direct part in the formation of the embryo. Their significance remains, to Oppel, an open question.

Polyspermy has been noticed in reptiles also by Todaro, in the trout by H. Blanc, in petromyzon and in batrachians by von Kupffer and in insects by Henking and by Blochmann.

These observations upon the wide occurrence of polyspermy, however much they may favor the idea of the normal occurrence of polyspermy in elasmobranchs, offered no clue as to the fate of the supernumerary sperms.

To support his thesis that these sperms become the yolk nuclei, the author makes use of the following rather unsatisfactory evidence:

Having shown that the merocyte nuclei cannot have arisen from the female pronucleus or from the segmentation nucleus, the question as to their origin narrows itself down to some form of external accession, free cell formation being excluded on general grounds. Of such external origin the possibility of inwandering maternal cells cannot be altogether denied, yet that many, possibly all, the yolk nuclei

[3]Anatom. Anzeiger, vii. May, 1892.

[4]Anatom. Anzeiger, vi, 1891. Also Archiv. f. Mik. Anat., xxxix, 1892.

(merocyte nuclei) come from inwandering supernumerary sperms results from the character of the nuclear figures formed in the division of these nuclei. In comparing the cleavage nuclei with the yolk nuclei the author finds that the latter have at most *half as many* chromatin loops in the spindle stage; these loops are also thicker and shorter. Such reduced nuclei can have come only from sexual cells, from sperms in this case.

In spite of this ingenious nuclear criterion the author cannot affirm that all merocyte structures, even in the elasmobranchs studied, arise from polyspermy, so that the meaning and fate of such bodies is not left in a very satisfactory condition.

ENTOMOLOGY.[1]

Iowa Insects.—Prof. Herbert Osborn, of the Iowa Agricultural College, has recently distributed three important papers concerning Iowa insects. The first[2] gives an annotated list of the Orthoptera of Iowa, and the second[3] is a catalogue of the Hemiptera of Iowa. Both are important contributions to our knowledge of insect distribution. The third[4] paper adds lists of the Hymenoptera, Lepidoptera and Coleoptera of the State. The author considers each of these lists as preliminary, and they doubtless will prove very useful in working up more completely the fauna of Iowa.

Distribution of Spiders.—Until very recently our knowledge of the distribution of North American spiders was very incomplete, there being practically no catalogues of the species found in given localities. Several important papers, however, have lately appeared, which add much to our knowledge of the subject. Mr. Nathan Banks has catalogued The Spider Fauna of the Upper Cayuga Lake Basin[5] in an important paper of over seventy pages, illustrated by five full-page plates. Three-hundred and sixty-three species are enumerated, a large number of which are here described for the first time. Dr. George Marx in his annual address as President of the Entomological Society of Washington, last year[6] gave a list of the Araneæ of the

[1]This department is edited by Prof. C. M. Weed, Hanover, N. H.

[2]Trans. Iowa Acad. Sci., Vol. i, pp. 116–120.

[3]Trans. Iowa Acad. Sci., Vol. i, pp. 120–131.

[4]A partial catalogue of the animals of Iowa. Ames, Iowa, 1892.

[5]Proc. Phila. Acad., 1892.

[6]Proc. Ent. Soc. Wash., ii, pp. 148–161.

District of Columbia, in which 370 species are recorded, sixty-two of which are new and undescribed. The localities and dates are given. Mr. J. H. Emerton, in the last issue of *Psyche*, announces that his The New England Spiders is ready for distribution, the work consisting of papers published in seven parts in the Transactions of the Connecticut Academy of Arts and Sciences, Vols. vi, vii, and viii. There are descriptions of 340 species and 1400 figures.

Dr. Marx has also prepared[7] a contribution to the study of the spider fauna of the Arctic Regions, compiling a list of 292 species which have so far been found and described from the Arctic regions of the globe. A large number of these are described in a manuscript paper by Dr. Marx that is not yet published. The author summarizes the results of a close study of the polar spider fauna of both hemispheres as follows:

1. "The Arctic spider fauna is composed of the ten families which we may term the common ones, their species constituting the main bulk of the entire spider fauna of the world. They are cosmopolitans, and are found almost wherever animal life is possible.

2. "The genera of the Arctic spider fauna are, without exception, those which also occur in other regions of the world, and there has been found so far not one genus which is original to that zone of eternal ice and snow. This is a very remarkable fact, since in all other Arthropod orders, and those of higher rank, the polar fauna is distinguished by special and peculiar forms.

3. "Even among this species a vast number occur which live in milder climates and under entirely different conditions and influences, and we find some families represented by only such forms, lacking entirely original Arctic species.

4. "The differences between the faunas of the Eastern and Western Hemispheres are slight, and, generally speaking, those forms which are most frequently represented in one are also found in the larger proportion in the other."

The Encyrtinæ.—Mr. L. O. Howard publishes[8] an interesting synopsis of the Encyrtinæ with branched antennæ. He includes six genera, three of which—Calocerinus, Tetracladia, Pentacnemus—are new. Three new species are also described. The paper is illustrated by two excellent plates.

[7]Proc. Ent. Soc. Wash., ii, pp. 186–200.

[8]Insects of the sub-family Encyrtinæ with branched antennæ. Proc. U. S. Nat. Mus., No. 905.

Directions for Collecting Insects.—Dr. C. V. Riley has prepared and the National Museum has published (Bulletin No. 39, Part F), an admirable pamphlet entitled Directions for Collecting and Preserving Insects. It contains 147 pages and almost as many illustrations, and covers the field in a thorough and systematic manner. It will prove invaluable to all young entomologists, and there are few older ones who cannot derive useful hints from it.

Number of Insect Species.—In the introductory portion of the bulletin just referred to Dr. Riley writes: "The omnipresence of insects is known and felt by all; yet few have any accurate idea of the actual numbers existing, so that some figures will not prove uninteresting in this connection. Taking the lists of described species and the estimates of specialists in the different orders, it is safe to say that about 30,000 species have already been described from North America, while the number of species already described or to be described in the Biologia Centrali-Americana, i. e., for Central America, foot up just about the same number, Lord Walsingham having estimated them at 30,114 in his address as President of the London Entomological Society two years ago, neither the Orthoptera nor the Neuroptera being included in this estimate. By way of contrast the number of mammals, birds, and reptiles to be described from the same region is interesting. It foots up 1937, as follows:

"Mammals, 180; birds, 1600; reptiles, 157.

"If we endeavor to get some estimate of the number of insects that occur in the whole world, the most satisfactory estimates will be found in the address just alluded to and in that of Dr. David Sharp before the same society. Linnæus knew nearly 3000 species, of which more than 2000 were European and over 800 exotic. The estimate of Dr. John Day in 1853 of the number of species on the globe was 250,000. Dr. Sharp's estimate thirty years later was between 500,000 and 1,000,000. Sharp's and Walsingham's estimates in 1889 reached nearly 2,000,000, and the average number of insects annually described since the publication of the Zoological Record, deducting 8 per cent for synonyms, is 6500 species. I think the estimate of 2,000,000 species in the world is extremely low, and if we take into consideration the fact that species have been best worked up in the more temperate portions of the globe, and that in the more tropical portions a vast number of species still remain to be characterized and named, and if we take further into consideration the fact that many portions of the globe are yet unexplored entomologically, that even in the best

worked up regions by far the larger portion of the Micro-Hymenoptera and Micro-Diptera remain absolutely undescribed in our collections, and have been but very partially collected, it will be safe to estimate that not one-fifth of the species extant have yet been characterized or enumerated. In this view of the case the species in our collections, whether described or undescribed, do not represent perhaps more than one-fifth of the whole. In other words, to say that there are 10,000,000 species of insects in the world, would be, in my judgment, a moderate estimate."

MICROSCOPY.[1]

Gulland's Method of Fixing Paraffine Sections to the Slide.[2]—After pointing out the difficulties arising from the use of the albumen fixative the author offers the following method:

The tissue is imbedded in the usual manner. In trimming the block for sectioning, care must be taken to see that the surface meeting the razor is exactly parallel to the opposite surface; these surfaces are then coated with soft paraffine, and when this has hardened are again trimmed square. The reason for this special care is that any curve in the ribbon produced by neglect of this precaution is accentuated by the later flattening of the sections. When all the sections required have been cut the ribbon is divided into lengths corresponding to that of the cover glass in use.

A flat glass dish filled with warm water is now provided; the temperature should never be high enough to melt the soft paraffine holding the sections together. Short of this, however, the warmer the water the more rapidly and completely are the sections flattened.

The ribbons are seized at one end with forceps while the other end is gently lowered upon the surface of the warm water; as the sections flatten out they will move along the surface of the water; when the flattening is complete the slide, carefully cleaned, is immersed in the water. The ribbon is floated into its position with a stiff brush; this process is repeated until the slide is full, when it is set up on end until the water is thoroughly drained off. The slide is then transferred to the top of the imbedding oven, where the temperature is a little under 50° C., and where, consequently, the paraffine of the sections is not

[1]This department is edited by C. O. Whitman, Chicago University.

[2]Jour. of Anat. and Physiol., Vol. xxvi.

melted, though the water rapidly evaporates. The slides are kept there, with a cardboard cover over them to keep off dust, until the evaporation is complete and the sections adhere to the slide. The time required for this varies according to the thickness of the sections; for thin sections one hour is generally sufficient for complete fixation, but the important point is that *the paraffine must never be melted until the last trace of water has disappeared from the slide.*
melted until the last trace of water has disappeared from the slide.
If this premature melting happens by any accident the sections are certain to peel off later. A few experiments enable one to be sure of the point when the slides are safe.

After complete fixation the paraffine is melted by putting the slide inside the oven, then washed off with turpentine or xylol.

One of the great advantages of this method is the perfect ease and safety with which it allows sections on the slide to be manipulated, so that the most various stains and reagents can be applied successively to a slide, *e. g.*, the complicated processes used to demonstrate bacteria in the tissues can be applied, with the certainty, moreover, that there is nothing on the slide to be stained which was not in the section.

A Method of Killing Nematodes for Microtome Sections.—Inquiries from several zoologists as to how Nematodes may be prevented from curling while being killed, leads me to publish the following very simple but satisfactory method. This method, so far as I know, was first used by my friend, Dr. Kaiser, in preparing *Echinorhynchus* for the microtome, and I have now used it several years and find it indispensible in fixing Nematodes and other worms.

A worm—only one can be killed at a time—is placed upon a large slide with a few drops of water; a second slide is placed over the worm and moved slowly to and fro. This movement causes the worm to straighten. As soon as the Nematode assumes the desired position the fixing liquid is pipetted between the slides, the motion of the upper slide being continued until the worm is dead. By this method one can obtain a specimen which is perfectly straight and round. If the worm is delicate, too much pressure must not be used during the rolling process. Pressure may be avoided by pasting a piece of paper on the upper surface of the second slide and using that as a handle.

As killing liquid I generally use the following solution: Corrosive sublimate + alcohol 70% + a few drops of acetic acid heated to 50° C., which passes through the cuticle very quickly.—C. W. S.

SCIENTIFIC NEWS.

The New Royal Bohemian Museum has set apart a special room for the exhibition of the collection of fossils made by the Dr. J. Barrande, illustrating his Système Silurien de la Bohème. In this connection it may be stated that the Barrande Fund, founded by Dr. Fritsch to carry on the work that ceased at Barrande's death, has now reached the sum of 10,000 florins. The interest on this fund will be available next year for the endowment of research in the Silurian formation in Bohemia.

The scientific world has sustained a loss in the death of Dr. Otomar Novàk, Professor of Geology in the Bohemian University of Prague. The sad event occurred July 29. The Professor was occupied with a continuation of Barrande's work on the Silurian fossils of Bohemia, specially investigating the corals.

Dr. H. J. Tylden, who died recently in England of typhoid fever, is supposed to have become innoculated while engaged in investigating the etiology of the disease. He had published a short time before his death an article in *Nature* on the Bearing of Pathology upon the Doctrine of the Transmission of Acquired Characters.

Prof. von Graeff will have charge of an expedition next spring to the tropics to collect material for the completion of the second volume of his Monograph of the Turbellaria. The expenses will be defrayed by the Imperial Academy of Sciences of Vienna.

Dr. George A. Koenig, late of the University of Pennsylvania, has been appointed Professor of Chemistry at the Michigan Mining School, Houghton. Prof. Koenig is one of the most accomplished mineralogists and metallurgists in the United States, and the University of Pennsylvania has suffered a serious loss.

Materials for a museum of ethnology at Chicago are now being collected in South America.

The Philadelphia Academy of Natural Sciences has commenced the erection of the new wing of its museum. This will be 130 feet by 50, with an addition to the front of 50x47 feet, and will have four stories and a light basement.

Table of Contents of The North American Review for October, 1892.—A VINDICATION OF HOME RULE.—*A reply to the Duke of Argyll, by the Right Hon. W. E. Gladstone, Prime Minister of England.*—The Excise Law and the Saloons, the Right Rev. Bishop Doane; The Real Issue, Senator Vest, of Missouri; The

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The Tenth Congress of the American Ornithologists' Union will convene in Washington, D. C., on Tuesday, November 15, 1892, at eleven o'clock a. m.

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AMERICAN NATURALIST

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THE ORIGIN OF LUNGS, A CHAPTER IN EVOLUTION.

BY CHARLES MORRIS.

The air bladder of fishes is an organ whose true purpose has long been classed among the mysteries of animal organization. All we know about it is the duty to which it is now occasionally devoted; but there is abundant reason to believe that this was not its original function. This duty is indicated by its frequent title of "swim-bladder," the organ being seemingly used to some extent to aid the fish in swimming. Cuvier tells us that "the most obvious use of the swim-bladder is to keep the animal in equilibrium with the water, or to increase or reduce its relative weight, and thereby cause it to ascend or sink, in proportion as that organ is dilated or compressed." In addition it may be of use, as Günther observes, "in raising the fore-part of the body or depressing it, as occasion may require."

Doubtless all this is correct, but that the bladder was evolved for such a purpose, or is of any essential utility as a swimming organ, there is the strongest reason to question: and in all probability its original purpose was something quite different. As it at present exists it is often too small to be of use in changing the gravity of the fish, and in many cases it is entirely absent. In others, its compressing muscles, as Van der Hœven states, seem incapable of being used to expand it. Yet in all these cases the fish seems at no disadvantage in swimming as compared with those that possess large and

efficient bladders. As an instance may be cited the mackerel, which has no bladder, yet which certainly finds no difficulty in rising or sinking. The same may be said of the great shark tribe, which is bladderless. All this goes to indicate that the air bladder could not have been developed originally for such a purpose, since its use as a swim-bladder seems of such little value to the fish that it has been frequently suffered to degenerate and disappear, and even if such a service were essential to the fish tribe it is impossible to conceive that this organ could have been of utility in swimming in the earlier stages of its development.

Before considering, however, the question of the original purpose of the air-bladder, some description of its present conditions is necessary. This organ is an internal sac, possessed by many, but not by all, fishes, and is situated ordinarily in the dorsal region of the body, between the vertebræ and the intestines, and in front of the kidneys. It lies outside the peritoneal sac, a fold of which invests its ventral surface. Its relation to the surrounding organs varies. In many cases it is intimately adherent to the vertebral column and the abdominal tissues, and is often enclosed in osseous capsules formed by the vertebræ. In such cases it may readily be compressed or expanded, and the weight of the fish in relation to the water be thus changed. But in other instances it is almost loose in the abdominal cavity, and seemingly incapable of acting as a gravity organ.

It varies greatly both in size and form. In some fishes it is so large as to extend into the tail, while in other instances it sends processes into the head; these having some connection with the organ of hearing. In many fishes, on the contrary, it is small, sometimes so minute as to be of no conceivable utility. In numerous instances it is entirely absent. And here we find the highly significant fact that variations of this kind occur in closely related species. Thus, as has been already said, the mackerel has no air-bladder. Yet one exists in *Scomber pneumatophorus*, a species which in every other respect closely resembles the mackerel. Similarly in the genus *Polynemus* one species (*paradiseus*) is destitute of an air-

bladder, while every other species possesses one. A like singular variation occurs in the case of related genera. In the genus *Sebastes* the air-bladder is very large, yet in a closely related genus it is scarcely the size of a pea.

Its variations in form are equally marked. Ordinarily it is a simple sac, with smooth interior. Yet in some instances it has a cellular interior, and in others it is divided by transverse partitions into from two to four sections. In other cases it is divided by a longitudinal partition into two lateral halves. In some families there is a remarkable development of lateral appendages, of varying character. In others the internal sacculation becomes so great that the bladder resembles the batrachian lung, and evidently does duty in the breathing of air.

The bladder itself is composed of two layers of membrane, the outer one being usually provided with muscular fibres, while the inner one is abundantly supplied with blood vessels. These take the form of capillary plexuses, or what are known as *retia mirabilia,* whose purpose may be to secrete the gas with which the bladder is filled. This gas differs in character in different fishes. In fresh-water fishes it is nearly pure nitrogen, the percentage of oxygen being small. In marine fishes, on the contrary, oxygen is in excess. This is particularly the case in the deep-swimmers, in some of which the bladder has been found to contain as much as eighty-seven per cent. of oxygen.

These gaseous contents, if, as seems probable, obtained through secretion by the blood vessels, are not always so obtained, for in many fishes an arrangement exists by which air may directly enter the bladder from without. This is what is known as the pneumatic duct, a tubular connection between the œsophagus and the air-bladder, not unlike that which supplies the lungs of air-breathers. This duct presents the same remarkable variability which we have observed in other characteristics of the air-bladder. Its point of connection with the alimentary tract varies, being usually in the œsophagus, but in some fishes as far back as the stomach. In the Ganoid order of fishes the duct is a short one, and always

open. In the Physostome order it is longer, and in many instances is closed, it being occasionally reduced to a fine filament. In the other orders of Teleostean fishes, which embrace the great majority of species, the pneumatic duct does not exist. Whatever function this duct may have once performed, therefore, it seems as a rule to have lost its utility. That its function was an essential one in the early stage of fish life is rendered evident by the fact that all fishes which have a bladder at all possess a pneumatic duct in the larval stage of growth, this duct, in most cases, vanishing as they grow older.

If now we seek to discover the original purpose of this organ, there is abundant reason to believe that it had nothing to do with swimming. Certainly the great family of the sharks, which have no bladder, are at no disadvantage in changing their depth or position in the water. Yet if the bladder is necessary to any fish as an aid in swimming, why not to all? And if this were its primary purpose, how shall we explain its remarkable variability? No animal organ with a function of essential importance presents such extraordinary modifications in related species and genera. In the heart, brain, and other organs there is one shape, position, and condition of greatest efficiency, and throughout the lower forms we find a steady advance towards this condition. Great variation, on the other hand, usually indicates that the organ is of little functional importance, or that it has lost its original function. Such we conceive to be the case with the air-bladder. The fact of its absence from some and its presence in other fishes of closely related species, goes far to prove that it is a degenerating organ; and the same is shown by the fact that it is useless in some species for the purpose to which it is applied in others. That it had, at some time in the past, a function of essential importance there can be no question. That it exists at all is proof of this. But its modern variations strongly indicate that it has lost this function, and is on the road towards extinction. Larval conditions show that it had originally a pneumatic duct as one of its essential parts, but this has in most cases disappeared. The bladder itself has in many cases partly or wholly disappeared. Where preserved, it seems to be through

its utility for some secondary purpose, such as an aid in swimming or in hearing. That its evolution began very long ago there can be no question; and the indications are that it began long ago to degenerate, through the loss of its primitive function.

What was this primitive function? In attempting to answer this question we must first consider the air-bladder in relation to the fish tribe as a whole. In one principal order of fishes, the Elasmobranchs, the air-bladder does not exist. No shark or ray possesses this organ. In some few sharks, indeed, there is a diverticulum of the pharynx which may be a rudimentary approach to the air-bladder; but this is very questionable. The conditions of its occurrence in the main body of modern fishes, the Teleostean, we have already considered. But in the most ancient existing order of fishes, the Ganoids, of which but a few representatives remain, it exists in an interesting condition. In every modern Ganoid the air-bladder has an effective pneumatic duct, which usually opens into the dorsal side of the œsophagus, but in the sub-order Polypterus opens, like the wind-pipe of lung-breathers, into the ventral side. Finally, in the small sub-order of Dipnoi, also a survivor from the remote past, the duct not only opens ventrally into the œsophagus, but the air-bladder does duty as a lung. Externally it differs in no particular from an air-bladder; but internally it presents a cellular structure which nearly approaches that of the lung of the bactrachians. There are three existing representatives of the Dipnoi. One of these, the Australian lung-fish (*Ceratodus*), has a single bladder, which, however, is provided with breathing pouches having a symmetrical lateral arrangement. It has no pulmonary artery, but receives branches from the *Arteria cœliaca*. In the other two forms, *Lepidosiren* and *Protopterus*,—the kindred "mud fishes" of the Amazon basin and tropical Africa,—the bladder or lung is divided into two lateral chambers as in land animals, and is provided with a separate pulmonary artery.

The opinion seems to be tacitly entertained by physiologists that this employment of the air-bladder by the Dipnoi as a

lung is a secondary adaptation, a side issue from its original purpose. To this I venture to oppose the theory (which I have already offered in the "Proceedings" of the Academy of Natural Sciences of Philadelphia) that it is the original purpose, and that its degeneration is due to the disappearance of the necessity of such a function. As regards the gravitative employment of the bladder, the Teleostean fishes, to which this function is confined, are of comparatively modern origin; while the Dipnoi are surviving representatives of a very ancient order of fishes, which flourished in the Devonian age of geology, and in all probability breathed air then as now; and the Ganoids, which approach them in this particular, are similarly ancient in origin, and were the ancestors of the Teleosteans. The natural presumption, therefore, is that the duty which it subserved in the most ancient fishes was its primitive function.

The facts of embryology lend strong support to this hypothesis. For the air-bladder is found to arise in a manner very similar to the development of the lung. They each begin as an outgrowth from the fore-part of the alimentary tract, the only difference being that the air-bladder usually rises dorsally and the lung ventrally. The fact already cited, that the pneumatic duct is always present in the larval form, in fishes that possess a bladder, is equally significant. All the facts go to show that the introduction of external air into the body was a former function of the air-bladder, and that the atrophy of the duct in many cases, and the disappearance of the bladder in others, are results of the loss of this function.

Such an elaborate arrangement for the introduction of air into the body could have, if we may judge from analogy, but one purpose, that of breathing, to which purpose the muscular and other apparatus for compressing and dilating the bladder, now seemingly adapted to gravitative uses, may have been originally applied. The same may be said of the great development of blood capillaries in the inner tunic of the bladder. These may now be used only for the secretion of gas into its interior, but were perhaps originally employed in the respiratory secretion of oxygen. In fact, all the circum-

stances mentioned—the similarity in larval development between bladder and lung, the larval existence of the pneumatic duct, the arrangements for compressing and dilating the bladder, and the capillary vessels on its inner tunic—point to the breathing of air as its original purpose.

It is probable that the Ganoid, as well as the Dipnoid, bladder, is to some extent still used in breathing. The Dipnoi have both lungs and gills, and probably breathe with the latter in ordinary cases, but use their lungs when the inland waters in which they live become thick and muddy, or are charged with gases from decomposing organic matter. The Ganoid fishes to some extent breathe the air. In *Polypterus* the air-bladder resembles the Dipnoid lung in having lateral divisions, and a ventral connection with the œsophagus, while in *Lepidosteus* (the American Gar Pike) it is cellular and lung-like. This fish keeps near the surface, and may be seen to emit air-bubbles, probably taking in a fresh supply of air. The American Bow-Fin or Mud Fish (*Amia*) has a bladder of the same lung-like character, and has been seen by Wilder to come to the surface, open its jaws widely, and apparently swallow a large quantity of air. He considers that both *Lepidosteus* and *Amia* inhale and exhale air at somewhat regular intervals, resembling in this the salamanders and tadpoles, "which, as the gills shrink and the lungs increase, come more frequently to the surface for air."

As the facts stand there is no evident line of demarcation between the gas-containing bladders of many of the Teleosteans, the air-containing bladders of others and of the Ganoids, and the lung of the Dipnoi, and the indications are in favor of their having originally had the same function, and of this being the breathing of air.

If now we ask, what were the conditions of life under which this organ was developed, and what the later conditions which rendered it of no utility as a lung, some definite answer may be given. The question takes us back to the Devonian and Silurian geological periods, during which the original development of the bladder probably took place. In this era the seas were thronged with fishes of two distinct orders, the Elasmo-

branchs and the Dipnoi, with the Ganoids as a branch of the true fishes. The former were without, the latter with, an air-bladder; a difference in organization which was most likely due to some marked difference in their life habits. The Elasmobranchs were the monarchs of the seas, against whose incursions the Ganoids put on a thick protective armor, and probably sought the shallow shore waters, while their foes held chief possession of the deeper waters without.

We seem, then, to perceive the Ganoid fishes driven by their foes into bays and estuaries and the waters of shallow coasts, ascending streams, and dwelling in inland waters. Here two influences probably acted on them. The waters they dwelt in were often thick with sediment, and were doubtless in many instances poorly aerated, rendering gill-breathing difficult. And the land presented conditions likely to serve as a strong inducement to fishes to venture on shore. Its plant life was abundant, while its only animal inhabitants seem to have been insects, worms, and snails. There can be little doubt that the active fish forms of that period, having no enemies to fear on the land, and much to gain, made active efforts to obtain a share of this vegetable and animal food. Even to-day, when they have numerous foes to fear, many fishes seek food on the shore, and some even climb trees for this purpose. Under the conditions of the period mentioned there was a powerful inducement for them to assume this habit.

Such conditions must have strongly tended to induce fishes to breathe the air, and have acted to develop an organ for this purpose. In addition to the influences of foul or muddy water and of visits to land, may be named that of the drying-out of pools, by which fishes are sometimes left in the moist mud till the recurrence of rains, or are even buried in the dried mud during the rainless season. This is the case with the modern Dipnoi, which use their lungs under such circumstances. In certain other fresh-water fishes, of the family Ophiocephalidæ, air is breathed while the mud continues soft enough for the fish to come to the surface, but during the dry period the animal remains in a torpid state. These fishes have no lungs, but breathe the air into a simple cavity in the pharynx, whose

opening is partly closed by a fold of the mucous membrane. Another family, the Labyrinthici, of similar habits, possesses a more developed breathing organ. This is a cavity formed by the walls of the pharynx, in which are thin laminæ or plates, which undoubtedly perform an oxygenating function. The most interesting member of this family is *Anabas scandens*, the Climbing Perch. In this fish, which not only leaves the water, but climbs trees, the air-breathing organ is greatly developed. The Labyrinthici moreover have usually large air-bladders. As regards the occasional breathing of air by fishes, even in species which do not leave the water, it is quite common, particularly among fresh-water species. Cuvier remarks that air is perhaps necessary to every kind of fish; and that, particularly when the atmosphere is warm, most of our lacustrine species sport on the surface for no other purpose.

It is not difficult to draw a hypothetical plan of the development of the air-bladder as a breathing organ. In the two families of fishes just mentioned, whose air-bladders indicate that they once possessed the air-breathing function and have lost it, we perceive the process of formation of an air-breathing organ beginning over again, under stress of similar circumstances. The larval development of the air-bladder points significantly in the same direction. In fact, we have strong reason to believe that air-breathing in fishes was originally performed, as it probably often is now, by the unchanged walls of the œsophagus. Then these walls expanded inwardly, forming a simple cavity, partly closed by a fold of membrane, like that of the Ophiocephalidæ. A step further reduced this membraneous fold to a narrow opening, leading to an inner pouch. As the air-breathing function developed, the opening became a tube, and the pouch a simple lung, with compressing muscles and capillary vessels. By a continuation of the process the smooth-walled pouch became sacculated, its surface being increased by folding into breathing cells. Finally a longitudinal constriction divided it into two lateral pouches, such as we find in the lung of the Dipnoi. This brings us to the verge of the lung of the Batrachia, which is but a step in

advance, and from that the line of progress is unbroken to the more intricate lung of the higher land animals.

The dorsal position of the bladder and its duct would be a difficulty in this inquiry, but for the fact that the duct is occasionally ventral. This dorsal position may have arisen from the upward pressure of air in the swimming fish, which would tend to lift the original pouch. But in the case of fishes which made frequent visits to the shore, new influences must have come into play. The effect of gravity tended to draw the organ and its duct downward, as we find in one family of the Ganoids and in all the Dipnoi; and its increased use in breathing required a more extended surface. Through this requirement came the pouched and cellular lung of the Dipnoi. Of every stage of the process here outlined, examples exist, and there is great reason to believe that the development of the lung followed the path above pointed out.

When the carboniferous era opened there may have been many lung- and gill-breathing Dipnoi, which spent much of their time on land, and some of which, by a gradual improvement in their organs of locomotion, changed into batrachians. But with the appearance of the latter, and of their successors, the reptiles, the relations of the fish to the land radically changed. The fin, or the simple locomotor organ of the Dipnoi, could not compete with the leg and foot as organs of land locomotion, and the fish tribe ceased to be lords of the land, where instead of feeble prey they now found powerful foes, and were driven back to their native habitat, the water. Nor did the change end here. In time the waters were invaded by the reptiles, numerous swimming forms appearing, which it is likely were abundant in the shallower shore line of the ocean, while they sent many representatives far out to sea. These were actively carnivorous, making the fish their prey, the great mass of whom were doubtless driven into the deeper waters, beyond the reach of their air-breathing foes.

In this change of conditions we seem to perceive an adequate cause for the loss of air-breathing habits in those fishes in which the lung development had not far progressed. It may, indeed, have been a leading influence in the development of

the Teleostean or bony fishes, as it doubtless was in the loss of its primitive function by, and the subsequent changes of, the air-bladder.

Such of the Ganoids and Dipnoi as survived in their old condition had to contend with adverse circumstances. Most of them in time vanished, while the Ganoids which still exist have lost in great measure their air-breathing powers, and the Dipnoi, in which the development of the lung had gone too far for reversal, have degenerated into eel-like, mud-haunting creatures, in which the organs of locomotion, which perhaps once served them efficiently for land travel, have become converted into the feeble paddle-like limb of Ceratodus and the filamentary appendages of the other species.

As regards the presence of a large quantity of oxygen in the bladders of deep-swimming marine fishes, it not unlikely has a respiratory purpose, the bladder being, as suggested by Semper, used as a reservoir for oxygen, to serve the fish when sleeping, or when, from any cause, not actively breathing. The excess of oxygen is not due to any like excess in the gaseous contents of sea-water, for the percentage of oxygen decreases from the surface downward, while that of nitrogen remains nearly unchanged. In all cases, indeed, the bladder may preserve a share of its old function, and act as an aid in respiration. Speaking of this, Cuvier says: "With regard to the presumed assistance which the swim-bladder affords in respiration, it is a fact that, when a fish is deprived of that organ, the production of carbonic acid by the branchiæ is very trifling," thus strongly indicating that the bladder still plays a part in the oxygenation of the blood.

Under the hypothesis here presented, the process of evolution involved may be thus summed up. Air-breathing in fishes was originally performed by the unchanged walls of the œsophagus, perhaps at specially vascular localities. Then the wall folded inward, and a pouch was finally formed, opening to the air. The pouch next became constricted off, with a duct of connection. Then the pouch became an air-bladder with respiratory function, and finally developed into a simple lung. These air-breathing fishes haunted the shores, their fins

becoming converted into limbs suitable for land locomotion, and in time developed into the lung- and gill-breathing batrachia, and these in their turn into the lung-breathing reptilia, the locomotor organs gradually increasing in efficiency. Of these pre-batrachia, we have existing representatives in the mud-haunting Dipnoi, with their feeble limbs. In the great majority of the Ganoid fishes the bladder served but a minor purpose as a breathing organ, the gills doing the bulk of the work. In the Teleostean descendants of the Ganoids the respiratory function of the bladder in great measure or wholly ceased, in the majority of cases the duct closing up or disappearing, leaving the pouch as a closed internal sac, far removed from its place of origin. In this condition it served as an aid in swimming, perhaps as a survival of one of its ancient uses. It gained also in certain cases some connection with the organ of hearing. But these were makeshift and unimportant functions, as we may gather from the fact that many fishes found no need for them, the bladder in these cases decreasing in size until too small to be of use in swimming; and in other cases completely disappearing, after having travelled far from its point of origin. In some other cases, above cited, the process seems to have begun again in modern times, in an eversion of the wall of the œsophagus for respiratory purposes. The whole process, if I have correctly conceived it, certainly forms a remarkable organic cycle of development and degeneration, which perhaps has no counterpart of similarly striking character in the whole range of organic life.

SOME USES OF BACTERIA.

By Dr. H. W. Conn.

(*Continued from Vol. XXVI, page 911.*)

I may now pass to the third branch of my subject and speak of the use of bacteria as scavengers in the world. A tree in the forest falls to the ground and it lies unmolested. It is at first hard, solid and impervious to all of the normal agencies. No insects can touch it; they cannot bite the hard wood to any extent. It lies there month after month. Little by little it begins to soften.

First the bark begins to get soft and finally falls off. By-and-by the wood gets quite soft, so that you can easily cut it, and perhaps run a pointed stick into it. Then insects get hold of it, and they begin to eat it; they bore tunnels and begin to crawl through it. The tree grows softer and softer, and finally, as you all know from observation many times, the trunk of this tree becomes softened into a mass of brown powder which sinks down into the soil and disappears. What has become of that tree? A bird dies and falls on the ground, and unless some animal comes along to eat the bird you will notice that the tissues of the bird very soon begin to undergo changes; they begin to soften; gases rise from them; the flesh of the bird undergoes the process which we call putrefaction, and that putrefaction results in the gradual decomposition of the tissues. Little by little part of the material passes off into the air as gas, and the rest of it sinks down into the soil and the bird disappears. What has produced all of these changes? Did it ever occur to you to ask what the condition of the surface of the earth would be at the present time if it were not for these processes which we call the processes of decay? Suppose there were no agencies which caused the gradual softening and destruction of trees and the dead bodies of animals. Long since the vegetable and animal life of this world would have disappeared, and we should have had the surface

of the earth covered with the accumulations of the growth of forests in past ages that would have tumbled upon each other until there would be such an accumulation of dead trees and dead leaves and dead vegetation of all kinds on the surface of the earth that plants would not be able to grow. The dead bodies of all the animals that have lived in the past would have been piled up until the whole surface of the world would have been so covered by the dead bodies of animals and plants that life would have become impossible. These scavengers, these bacteria, are absolutely necessary to us. It is through the agency of certain bacterial organisms that the tree is softened so that insects can get at it. It is through the agency of bacteria that the tissues of the bird are decomposed and gases produced which pass off into the air. It is these bacteria which cause all the changes in the bodies of animals and vegetables, decomposing them until they gradually sink down in the soil and disappear. So it is through their agency and this alone that the surface of the earth is kept in a condition which renders it possible for life to continue to exist. Of course you have all had experience of the value of bacteria as scavengers in removing bad odors. We speak of scavengers as of value in removing decaying material, but it is the bacteria which produce the decay, and it is through their agency that all of these dead bodies are broken to pieces and brought into a condition in which they can be either incorporated into the soil or passed off into the air.

Perhaps I may here also say a word in regard to the agency of bacteria as scavengers in the human body. We look upon bacteria in our bodies as causes of disease rather than things which are of any value, and yet a healthy person always has bacteria in large quantities in his mouth, in his stomach, and in his intestines. The bacteria are always migrating in the body to places of abnormal growths, and there is considerable reason for thinking that to a certain extent these bacteria act as scavengers in the human body. Some of them unquestionably act as producers of disease, but to a certain extent it seems that these bacteria are of a value in assisting in the decomposition of tissues that should be decomposed, and there

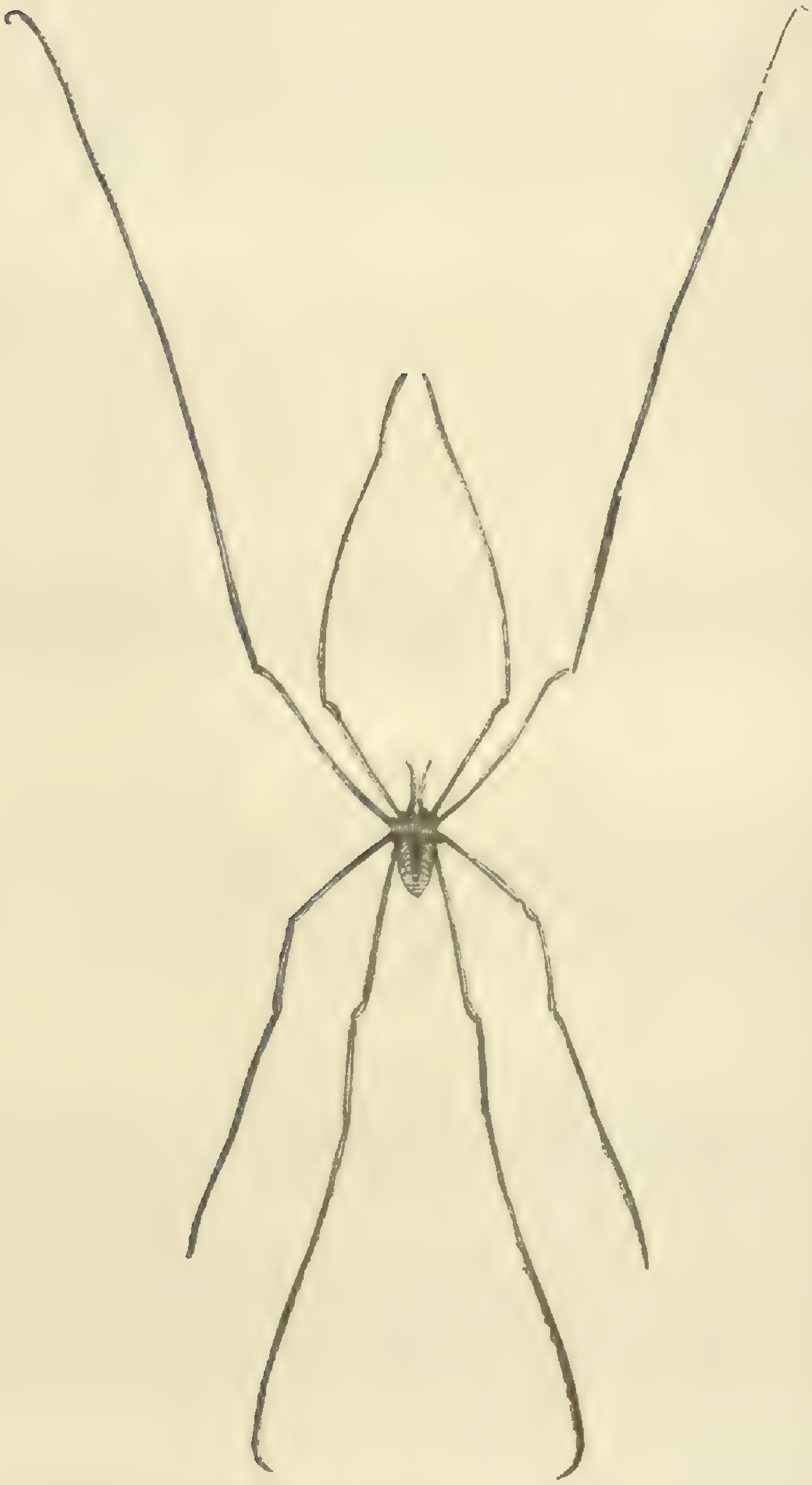
is reason for thinking that they assist in the digestion of food. There is no question that bacteria *may* assist in the process of digestion and it is doubtless a fact that the bacteria which we take into our alimentary canal are not wholly injurious. They may be possibly beneficial to us either in the line of scavengers in removing material which ought not to remain in our bodies, or in assisting digestion. This point, however, is not yet demonstrated, and I merely allude to it as a possibility.

Did it ever occur to you to ask why nature is perpetual? You know animals and plants have continued to live on the surface of the earth for hundreds and hundreds of centuries. The vegetation that has been growing on the surface of the earth has been constantly taking food out of the air and taking food out of the soil, and animals have been constantly feeding upon the plants. But the process seems to be a never-ending one. It would seem that the material for plant food and animal food would sometime be used up; and yet nature is perpetual. Now, the reason that nature is perpetual is, because animals and plants are enabled, by certain processes of nature, to use the same material over and over and over again. They can use material for food, and eventually that same material gets in a condition in which they can use it for food once more. Let me take a single illustration, one that you are probably all familiar with. Plants, as the result of their life, use up carbonic acid of the air, and, in return, send off into the air an equivalent amount of oxygen. Now, animals in their life, take out of the air a considerable amount of oxygen and send off from their bodies an equivalent amount of carbonic acid. You see here one of the adjustments of nature. Animals use the excretions of plants, plants use the excretions of animals. The animals take oxygen and give off carbonic acid, and the plants take carbonic acid and give off oxygen. This process goes on continually and thus the condition of the atmosphere, so far as oxygen and carbonic acid are concerned, is kept in the same normal state. Thus, so far as these gases are concerned, nature is enabled to be

perpetuated by the constant use of the same material over and over again.

Now, this is not only true in regard to oxygen and carbonic acid, but it is true also that all the other foods of animals and plants are capable of being used over and over again. Plants live upon phosphates, sulphates, and nitrates chiefly, as well as carbonic acid. Animals live upon such things as albuminoids and starches and sugars. Now, plants cannot live on the food of animals, and animals cannot live on the food of plants. You and I cannot live upon sulphates and phosphates and potassium salts and nitrates and carbonic acid. These are what we call inorganic compounds in nature. Animals cannot feed upon them, but plants can do so. The plants can take those materials and manufacture out of them the starches and sugars and fats and albuminoids, and then we can take the starches and sugars and fats and albuminoids which have thus been manufactured for us and feed upon them. You see, therefore, that the plants serve as a medium of communication between animals and nature. The world is made up chiefly of inorganic compounds like these phosphates and sulphates and potassium salts, etc., and the plants serve as a means of communication between animals and the inorganic world, for the plants take these inorganic materials and make them into something which we can use as food. Plants, then, are the means which we have of making use of inorganic nature; or, in other words, the whole animal kingdom is parasitic upon plants. But plants are in their turn utterly unable to live upon animal foods. A plant cannot feed upon albumen, a plant cannot eat starch, a plant cannot eat sugar, a plant cannot eat fat; plants are unable to use the foods that animals use, and when the body of a plant dies, although it is in a condition to be used as food by animals, it is not in a condition to be used again as food for plants. The dead body of the bird is in a condition in which plants cannot make use of it at all. A plant cannot use the albumen of the bird's tissue; a plant cannot use the fats in an animal; a plant cannot feed upon the sugars that are in the dead sugar-cane; a plant cannot feed upon the

PLATE XXVII.



Liobunum vittatum Say. Male. Mississippi.

starches or the cellulose that is in the body of the dead tree. Nevertheless, the plants do succeed in getting hold of this food, and it is through the agency of these bacteria that we are speaking of this morning that they do it. Just as soon as the body of an animal or plant dies, the bacteria get into it, begin to grow in it, decomposing it, and pulling it to pieces. They pull the starch to pieces, they pull the sugar to pieces, and albumens and fats share the same destruction. Little by little they take those compounds which plants cannot feed upon, and, by shaking them to pieces, bring them down to simple combinations which plants can feed upon.

Of special importance is one particular kind of organism known as "the nitrifying organism," which produces nitric acid. Plants as I have said, cannot feed upon such things as albumen. The putrefying bacteria can decompose albumen and break it up into certain simple compounds, but ordinary putrefying bacteria are not able to break that albumen down far enough for plants to get hold of it. Plants have got to live upon such things as nitrates and salts of nitric acid. Now, there is one sort of bacteria living in the soil which gets hold of the albuminous compounds and forms nitric acid. This is the nitrifying organism, and the nitrification is the last stage in the decomposition process by which an albuminoid is converted into a condition in which plants can get hold of it. One practical application of this you are all familiar with in the ripening of fertilizers. You know that green manure is of absolutely or of practically no use as a fertilizer on your fields. You know that it must first stand for a while and ripen, or "rot," as you call it. Now, what is taking place in that fertilizer while it is ripening? Simply the series of changes that have been mentioned. That fertilizer contains chemical compounds of a high degree of complexity, compounds that the plants cannot feed upon; they are too highly complex for plants to use as food. Bacteria, however, get into that heap and begin to grow in it; and, as the fertilizer becomes ripened, these high chemical compounds are pulled to pieces, they become converted into simpler decomposition products, and eventually, if the ripening be

continued long enough, the fertilizer is in a condition fit for for the fields. Now, when put upon the fields, the plants can get hold of the material. You will see now what I meant when I stated at the beginning of my lecture that in spite of all the cultivating that you and your horses might do in the fields, it would be useless without the agency of these organisms. You might put on your fertilizer; but, if that fertilizer be not acted upon by bacteria, it will be of no use, and thus the bacteria come in to complete the operation which you began. You do your duty and the bacteria do theirs, and the consequence is, the fertilizers which you are using are brought into a condition in which the plants can get hold of them, and thus the food of plants is produced. You see, then, that in this way plants and animals are able to use over and over again the same material. The plant gets this material out of the soil and out of the air; the animal comes along then and feeds upon the plant; then the animal dies, and the plant dies, and the bacteria get into the body of the animal or plant, pull it to pieces and produce from it decomposition products, and they get into the soil in the form of nitrates and nitric acid compounds; or they go off into the air in the form of ammonia and carbonic acid. The bodies of these animals and plants are thus reduced to simple conditions and now the plants once more get hold of them, and use as food the same material that previous generations used. Thus over and over again the same material is used, and thus nature is kept perpetual. This is the explanation of the constant, perpetual growth in nature. This is the reason that nature does not exhaust itself. This is the reason that animals and plants have been enabled to grow upon the surface of the earth for the past hundreds and hundreds of centuries.

But this is not the end of the agency of bacteria in plant life. They are not only of value in ripening your fertilizers and in keeping up this constant growth of nature, but we have learned within the last two or three years that at the very foundation the growth of plants is absolutely dependent upon these organisms, and similarly in the future the continuance of the vegetable world must be also dependent upon

them. I have stated that nature is perpetual because the same material can be used over and over again. That is true in a sense, but not true completely, for you will see with a little thought that little by little the soil is being drained of its food, little by little the materials in the soil are being turned into the ocean. A tree grows, takes out of the soil its food, and finally dies. If it falls on to the ground, as I have described, the bacteria get at it and grow there until the tree eventually becomes wholly incorporated into soil so that it can be used once more as plant food. But it may be that the tree instead of falling in the forest falls into a river, drifts down the river, begins to decay, and eventually goes into the ocean. After the products of decomposition are passed into the ocean, there is no getting them back to the soil. "The sea will not give up its dead," and the ocean does not give up the nitrogen and the other salts that are gradually being carried to it by this process. Or, again, a plant grows and produces wheat, produces fruit, produces nuts, and the grain, the fruit, and the nuts are taken to the city to be used as food for men. The food is used by men, and most of it eventually gets into the sewage of the city, is carried down to the river, and from the river it is carried into the ocean. So here again through the sewage of our cities, the foods which are supplied to our cities are being thrown into the ocean and thus the soil is being drained of its foods. This process is not a rapid one. It is only slowly that the foods are being taken out of the soil and carried to the ocean. Nevertheless, it is the constant dropping that wears away the rock, and it is easy for us to see that if this process goes on age after age, our souls are inevitably doomed to exhaustion. You know that many fields have become sterile, that many farms have been worn out, that many gardens are becoming infertile. You cannot cultivate your fields as you used to without furnishing them food. In the old world this is quite noticeable. Although the constant drainage of the soil by these agencies is a slow one, it is a sure one, and if there be no way of getting nitrogen and other salts back from the ocean to the soil, it would seem that the life of all vegetation is inevitably doomed to exhaustion, and with

the life of vegetation the life of animals must cease. The whole living world must end.

When the scientist observed this fact he immediately looked around to see if there was not a remedy for it. Now, as far as some of the plant foods are concerned, there does not seem to be any occasion for fear. The phosphates, the sulphates and the potassium salts, which are plant foods, seem to exist on the surface of the earth in almost unlimited quantities. There have been immense amounts of these salts found in certain parts of the world, and they can be mined at very small expense; they can be taken all over the world and put directly upon the soil, so that the sulphates, phosphates and potassium salts are in practically unlimited quantities. We have no fear so far as they are concerned. For an indefinite number of ages to come there is plenty of this sort of food on the surface of the earth for us to supply to the soil. But that is not true of the nitrogenous foods. Of course every farmer knows to-day that nitrogenous food is one of the very essential foods of plants, and it is not true that there is an unlimited quantity of nitrogenous salts anywhere in the world. There are a few sources of nitrogen other than the soil. The chief one is the guano beds in the South Pacific. These are sources of nitrogenous compounds, and upon these sources the agricultural industry of the world has been drawing for years, and will continue to draw until they are exhausted. But these sources are far away. The nitrogen that we get from them is very expensive, and the store is very limited in quantity. We can see in the not very distant future the complete exhaustion of all these nitrogen beds. This has led scientists to look with a considerable degree of dismay upon the future of the vegetable world. What is going to happen when all the available nitrogen is used up? If we are going to continue to take the nitrogen from the soil and throw it into the ocean we will soon exhaust the soil, and if there is no store of nitrogen anywhere for our plants to draw upon what are our plants going to do in the future?

Now there is a store of nitrogen in the world which is absolutely unlimited, and that is in the air that surrounds us. The

air that we breathe is made up of four parts of nitrogen and one part of oxygen. There are quantities of nitrogen everywhere if the plants could only get hold of it, but it has been thought that plants cannot feed on the nitrogen in the air at all. Experiments have been carried on for a great many years to find out whether plants could not in some way or other get hold of the nitrogen of the air. If we could only prove that our plants can get hold of the nitrogen in the air then the problem is solved. But the experiments which have been carried on year after year have seemed to demonstrate that plants cannot use the nitrogen of the air for food, that it is not in a condition in which they can get hold of it. About ten years ago, however, certain experimenters in this country and in Europe found that in some of their experiments plants did in some way get hold of nitrogen from some source when it was not fed to them ; that a plant could be grown in sand absolutely free from nitrogen, and yet in some way that plant got hold of nitrogen ; the only source for it was out of the air. That led to further experimentation until within the last four or five years the results have all been pointing in one direction. They seem to show us that there is one family of plants at least, which is capable of getting hold of nitrogen out of the air. This is the plant family to which the pea, the bean and the clover belong. It is, in general, the pea family—the *Leguminosæ* family of plants. This family of plants in some way does succeed in getting nitrogen from some source when we do not give it to them as food, and it must be that they get it from the air. And yet those experiments are entirely contradictory to the earlier experiments which seemed to show that plants could not get hold of nitrogen in the air. The explanation was not found until a few years ago. Two or three years ago some experiments were performed in Germany which have finally led to the solution of the problem, at least in part, and, curiously enough, we find that the whole secret of the matter is connected with these organisms which I am discussing this morning. It is to bacteria that we owe this power which is possessed by plants of the pea family to get hold of nitrogen. If you plant peas in soil containing a cer-

tain species of bacteria, or at least certain species of micro-organisms, these micro-organisms crawl into the roots of the pea, and then begin to multiply inside the roots. The little roots begin to swell and there appear upon them a lot of minute nodules, which have received the name of "root-tubercles." If I am not mistaken some of those little root tubercles were shown to the meeting here last evening. These root tubercles, as I say, make their appearance, and it is found that wherever these root tubercles do make their appearance the plant gets hold of nitrogen and grow well. Where these root tubercles do not make their appearance the plant is unable to get hold of the nitrogen unless it is fed to them. Now these root tubercles are produced by bacteria, and these root tubercles are the agencies by which, in some as yet unexplained way, the pea gets nitrogen out of the air.

Thus you see that in the final analysis of the life of a plant, in the assimilation of nitrogen from the air, we are brought to the conclusion that it is the agency of these minute microscopic organisms that is the source of the assimilation of nitrogen from the air by plants. Thus we owe the growth of these plants to bacteria. How the bacteria get the nitrogen out of the air has not yet been explained.

Even before the scientists made this discovery the farmer had made the discovery practically on his farm. You have known that you could in some, to you inexplicable, way rejuvenate an old, worn-out soil by cultivating clover upon it, or by cultivating beans. That has been the practice of farmers for years. It has been found that in some way the cultivation of clover, instead of exhausting your soil as the cultivation of some plants does, really increases the fertility of the soil. You cultivate your clover for one season, then the next season you plow the roots into your soil, and you find the field will produce a better crop than before. This result is brought about through the agency of these organisms. The clover belongs to the family of peas, and clover is one of the plants that this particular species of bacteria that I am speaking of can attack. The bacteria in the soil get into these roots, grow in them, produce these root tubercles, and by means of these the clover

gets nitrogen out of the air and stores it up in its roots. The next season you plow the roots into the soil, and then come the nitrifying bacteria which pull the roots to pieces and decompose them into the condition of nitrates, and then the next season the plant which you sow gets hold of the nitrates which came from the roots of the clover and which has been brought there through the agency of these bacteria. You see, then, that the farmer owes everything to the bacteria.

I think you will find that I am justified in the statement I made at the beginning that the study of bacteriology to-day is even more truly a department of agriculture than of medicine. The bacteria belong to the farmer more truly, or at least as truly, as they belong to the physician.

Now I must draw my remarks to a close. Let me, in conclusion, say that we must not think too hardly of bacteria. It is true they are the causes of evil, it is true that they produce disease, but it is also true that they do good. It is true that they are our enemies but it is also true that they are our closest allies. It is true that without them we could not have our smallpox nor our yellow-fever, we could not have our diphtheria or our scarlet fever, neither could we have the epidemic which is at present going over this country, nor in fact should we have any of our epidemics were it not for the bacteria. But when we remember that it is through the agency of these organisms that we bake the loaf of bread that comes onto our table, that it is through their agency that the immense brewing industries are able to exist, that it is through their agency that the industries connected with the manufacture of alcoholic liquors are possible; that without them we could not get our vinegar or our lactic acid; that without them we could not make our ensilage; when we remember that these bacteria give the butter-maker the aroma of his butter; when we remember that it is the decomposition products of the bacteria that the cheese manufacturer sells in the market; when we remember their agency as scavengers, how it is that they keep the surface of the earth clean and fresh and pure and in a constant condition for the continued growth of plants; when we remember their value to the soil in decomposing the dead

bodies of animals and plants, and thus enabling the same material to be used over and over again for the support of life, and hence making possible a constant, perpetual condition of nature; and when we remember, lastly, that it is only through their agency that plants were originally enabled to get hold of nitrogen at all and that it is only through the agency of these bacteria that we may hope for a continuance of a supply of nitrogen to the soil, when we remember all these things I think we will recognize that the power of the bacteria for good far outweighs their power for evil. Without them we should not have our epidemics, but without them we should not exist. Without them it might be that some individuals would live a little longer, if we could live at all. It is true that bacteria, by the production of diseases once in a while, cause the premature death of an individual; once in a while they will sweep off a hundred or a thousand individuals, but it is equally true that if it were not for them plant life and animal life would be absolutely impossible on the face of the world.—*Connecticut Agric. Report, 1892.*

THE STRIPED HARVEST-SPIDER: A STUDY IN VARIATION.

By Clarence M. Weed.

In 1821 Thomas Say described in the Journal of the Academy of Natural Sciences of Philadelphia two species of harvest-spiders, one of which he named *Phalangium vittatum* and the other *Phalangium dorsatum.* He stated that the former "inhabits the Southern States" and that the latter "inhabits the United States." His descriptions in both cases were evidently drawn up from specimens not fully matured, and the characterizations are meagre and unsatisfactory. The two species are said to be similar in color, but distinguished from each other by the "terminal joint of the palpi being pectinated with spines" in *P. dorsatum.*

In 1868 Dr. H. C. Wood published extended descriptions of both these species.[1] He states that they are closely related, "the principal characters separating the two being found in the differences in coloration of the dorsum and legs, the trochanter not being black in *P. vittatum,* and the much greater hardness and roughness of the upper surface of the southern species." He adds that *P. vittatum* "may be looked upon as the southern representative of its nearest ally, *P. dorsatum,* of which I have never seen any specimens from farther south than Washington City."

Since Dr. Wood's paper was published I have treated of[2] these species two or three times, taking them out of the old genus Phalangium, and referring them to Liobunum. In 1889 I stated that "after examining hundreds of specimens of *dorsatum* and dozens of *vittatum,* I am unable to find any constant structural character by which they may be separated, though the difference in the size of the body and length of legs is very marked."

[1]Comm. Essex Institute, VI, pp. 18–21.

[2]Amer. Nat., XXI, p. 935; Bull. Ill. St. Lab. Nat. Hist. III, pp. 83–87.

TABLE I. LIOBUNUM VITTATUM SAY. MALE. COLUMBUS, OHIO.

No. of Specimen.	Measurements of body in mm.		Measurements of legs in mm.				Remarks.
	Length.	Width.	1st pair	2d pair	3d pair	4th pair	
1	—	—	33	67.4	34.4	49	Body not measured. Collected 20 Sept., 1889.
2	—	—	33	65.6	34	42.4	" " " " 19 " "
3	—	—	34.6	67.6	35	50	" " " " 18 " "
4	—	—	31.6	63.4	32	46	" " " " 20 " "
5	—	—	35.4	70	35.8	50	" " " " 20 " "
6	—	—	35	71	35.6	49	" " " " 19 " "
7	—	—	35	70.6	34 6	51	" " " " 21 " "
8	—	—	35	72	36	51	" " " " 18 " "
9	—	—	34.4	69	36	51	" " " " 21 " "
10	—	—	35	67	35.2	49	" " " " 18 " "
11	6.2	—	38 8	76	38	54.6	Collected 26 Sept., 1889.
12	6 8	—	35.4	69 8	36	50.6	" " " "
13	6.2	—	35	66.4	35.8	49 6	" " " "
14	5.2	—	39 4	76	40.2	57	" " " "
15	6.4	3	37.4	77.2	38	55	" 2 Oct., " Palpi 6.2 mm. long.
16	5.8	—	33	67.4	33.4	47	" 26 Sept., "
17	8	—	35.4	72.4	35 4	52	" 25 " "
Longest.	8		39.4	77.2	40.2	57	
Shortest.	5 2		31.6	63.4	32	42.4	
Difference	2.8		7.8	13 8	8.2	14 6	
Average.	6.3		35	69.8	35	50 2	

During the last eight years I have collected hundreds of these striped harvest spiders in half a dozen States—some of them widely separated—and have received from correspond-

TABLE II. LIOBUNUM VITTATUM DORSATUM SAY. MALE. URBANA, ILLINOIS.

No. of Specimen.	Measurements of body.			Measurements of legs.				Length of Palpi.	Remarks.
	Length.	Breadth.	Height.	1st pair	2d pair	3d pair	4th pair		
1	5.5	4	3	28	55	27.5	39	6	Collected 9 August, 1887.
2	6	4	3	25	50	26	37	6 7	〃 〃 〃 〃
3	6	4	3	26.5	54	27.5	40	7	〃 〃 〃 〃
4	5.5	4	3	25	45	25	34	6	〃 〃 〃 〃
5	6	4	3	24	46	24	34	6.5	〃 〃 〃 〃
6	6	4	3	26	51	26	37.5	6	〃 〃 〃 〃
Longest	6	4	3	28	55	27.5	40	7	
Shortest.	5.5	4	3	24	45	24	34	6	
Difference.	.5	0	0	4	10	3.5	6	1	
Average.	5.8	4	3	25.7	50.1	26	38.9	6.3	

ents many specimens from other localities. After a careful study of the material thus accumulated—aggregating nearly a thousand specimens—I conclude that we have to do with a single very variable species, in which natural selection has

increased the size of body and the length of legs to the southward, and shortened them in the north. The points of difference indicated by Say and Wood prove without value when many specimens are examined.

The harvest-spiders are well adapted for the study and illustration of organic variation. Their long legs are easily measured, and the results can be set down in black and white, with more striking effect than in the case of most invertebrates.

To determine the variability of the species in a given locality I measured seventeen fully developed males taken in the fall of 1889 at Columbus, Ohio. The results are shown in table I:

This shows a striking and constant variation, the longest of the fourth pair of legs being one-third longer than the shortest, and the difference in the other legs being nearly as great.

To determine whether similar variations occurred in other localities, six fully developed males, collected on the farm of the University of Illinois, were measured, with the results shown in Table II:

The fact that there was a difference of ten millimetres in the length of the second pair of legs in the case of six specimens, selected at random, indicates that this amount of variation, at least, is normal to the species in that locality.

Two fully developed males sent by Mr. J. M. Aldrich from Brookings, South Dakota gave the following measurements:

TABLE III. LIOBUNUM VITTATUM DORSATUM SAY. MALE. BROOKINGS, SOUTH DAK.

No. of Specimen	Measurements of body.			Mensurements of legs.				L'n'th of palpi	Remarks.
	Length	Breadth	Height	I	II	III	IV		
1	5	4	2.5	21	34	21	29	6.2	
2	5	3.5	2.3	19	35	19	26	6.1	
Average	5	3.8	2.4	20	34.5	20	27.5	6.15	

In striking contrast to this are the following measurements of two fully developed males from Mr. H. E. Weed, collected at the Mississippi Agricultural College:

TABLE IV. LIOBUNUM VITTATUM SAY. MALE. AGRICULTURAL COLLEGE, MISS.

No of Specimen	Measurements of body.			Measurements of legs				L'n'th of palpi	Remarks.
	Length	Breadth	Height	I	II	III	IV		
1	7	5	3.6	46	90	46	66	7.5	
2	7.5	4.5	3.5	47	90	46	65	7.5	
	7.25	4.75	6.55	46.5	90	46	65.5	7.5	

In Tables III and IV we have the two extremes in the size of the species, so far as my specimens show it. In the presence of these alone one would unhesitatingly decide that they belonged to two well marked species. The fact that in size of body the Mississippi form is nearly one-third larger; and that the first, third and fourth pairs of legs are considerably more than twice as long, while the second pair is nearly three times as long would in the absence of intermediate forms, fully justify such a separation. But a reference to Tables I and II drawn up from specimens taken about half way between Dakota and Mississippi shows that the size of the species in those localities is intermediate between the two extremes, the second pair of legs in central Illinois averaging 50.1 mm. and in central Ohio 69.8 mm. against 34.5 mm in South Dakota and 90 mm. in Mississippi.

The measurements of individual specimens from various localities given in Table V below indicate that the size of body and length of legs varies greatly with the locality, as a rule the body becoming larger and the legs longer as we go southward.

TABLE V. LIOBUNUM VITTATUM SAY. MALES FROM VARIOUS LOCALITIES.

Locality.	Measurements of body.			Measurements of legs.				L'n'th of palpi
	Length	Breadth	Height	I	II	III	IV	
Iowa (Ames)............	—	—	—	—	45	—	—	—
S. Maine (Orono)......	6	3.7	3	32	60	33	44	6
N. Illinois (Normal)..	6.5	4	3	31	59	31	45	6.7
N. Ohio (Brooklyn)...	5.5	4	3.1	35	67	35	—	—
S. Ohio (Ironton)......	6	4.2	3	40	82	40	58	6.4
Virginia (Blacksburg)	—	—	—	—	76	—	—	—
S. Illinois (Cobden)...	7	4	—	44	89	45	64	7

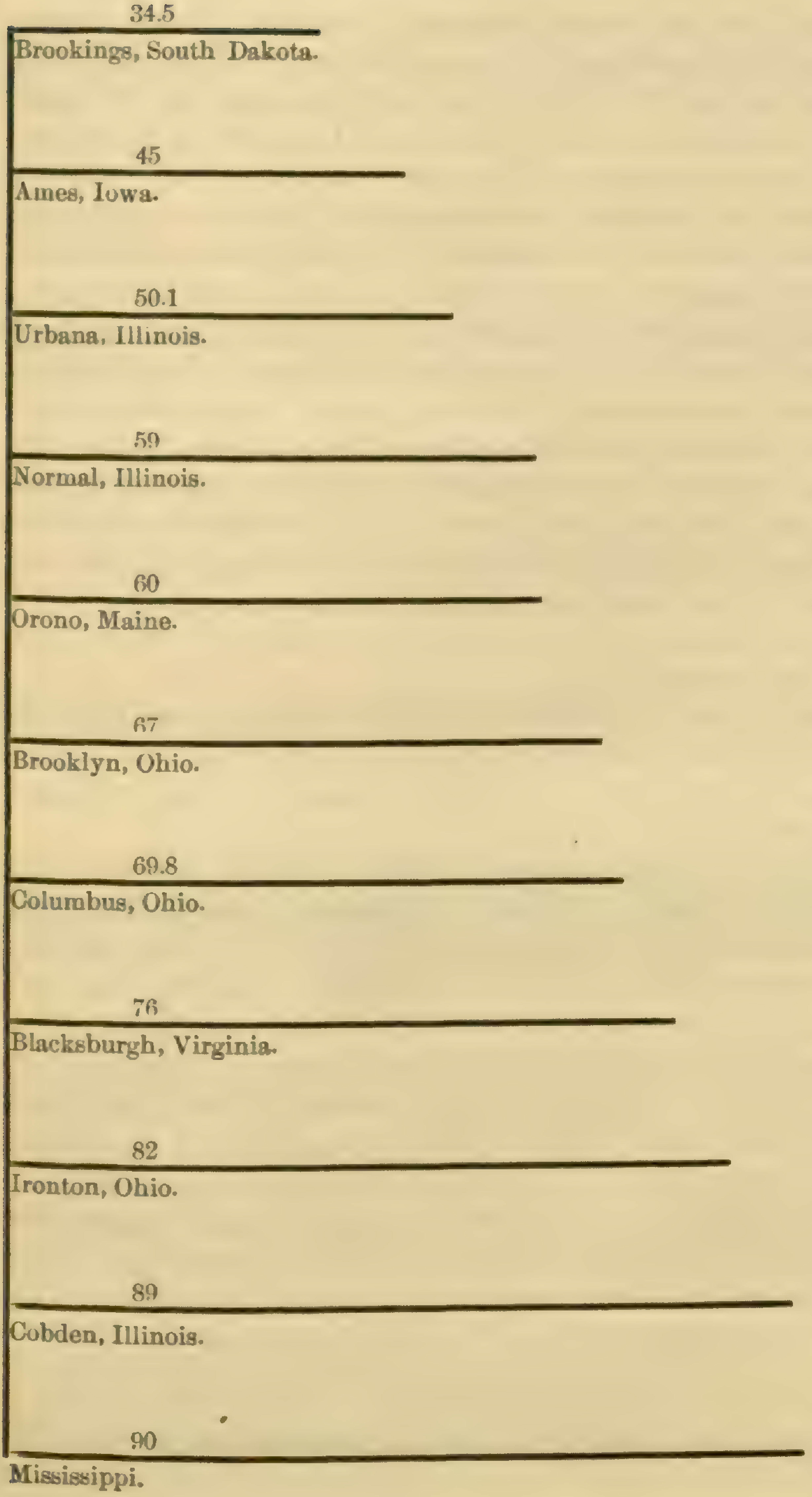
In the diagram on the following page I have reduced the lengths of the second pair of legs of the specimens from all the localities given above to straight lines, each line representing the precise length and the figures above it showing its measurement in millimetres. Where more than one specimen has been measured from a given locality the average is taken. It will be seen that the difference in the progressive lengthening from the north to the south is in no case greater than has been shown in Tables I and II to occur in a single locality. One can find no place where a line can be drawn separating the two forms. Considering in connection with this the fact that there are no structural or colorat'onal differences separating the two, it seems to me evident that, as already stated, we have here a single widely variable species. As the description of *P. vittatum* precedes that of *P. dorsatum* in the original publication, the species should be known as *Liobunum vittatum* (Say) and the northern form as *L. vittatum dorsatum* (Say). It would apparently be well to refer to *dorsatum* the forms from those localities in which the average length of the second pair of legs in the males is less than 70 or possibly 75 mm.

The above records have reference only to the males but a number of measurements of female specimens show that they vary in a similar manner.

Life-History.

This species evidently passes the winter in the egg state as it has never been taken during the winter or early spring months. The eggs of the northern form apparently do not hatch very early, probably not until May, and the young grow slowly. Occasionally I have found a fully developed one during the latter part of June, but generally they do not become mature until July. My collections show two half grown specimens taken at Columbus, Ohio, July 30, 1888, and another collected in the same locality July 16, 1888, which is not fully developed.

When very young these harvest-men seem to prefer the shelter of the grasses, low herbage and rubbish piles, but as they grow larger they are to be found in a great variety of sit-


34.5
Brookings, South Dakota.
45
Ames, Iowa.
50.1
Urbana, Illinois.
59
Normal, Illinois.
60
Orono, Maine.
67
Brooklyn, Ohio.
69.8
Columbus, Ohio.
76
Blacksburgh, Virginia.
82
Ironton, Ohio.
89
Cobden, Illinois.
90
Mississippi.

uations. In the prairie regions of central Illinois, where nearly all of the country is occupied by corn fields and Osage orange hedges, the young are very common on the corn plants, where, as I have elsewhere surmised, they probably live upon the numerous small insects drowned in the moisture contained in the bases of the unfolding leaves, as well as on the corn plant lice (*Aphis maidis*). The full grown individuals are to be found nearly everywhere, on bushes and trees in the woods, in meadows and pastures, along fences, and in sheds and outhouses. They occur abundantly from July to October.

The only opportunity I have had of studying the long-legged southern form in the field was in southern Illinois during the autumn of 1886. Along the rocky ledges running across the State and through Union County, these harvest-spiders were exceedingly abundant, occurring everywhere on the rocks and ground. They were so numerous that as one walked in the open groves on the farm of Mr. Parker Earle they would run along in droves.

This species, like others of its family has the power of exuding from about the coxæ a liquid with a peculiarly disagreeable odor. This doubtless serves as a protection from birds and other enemies.

An idea of the difference in length of legs between the species as it exists in Dakota and Mississippi may be obtained by comparing Fig. I, Plate XXIX, with Plate XXVII, the first representing a specimen from the former locality, and the second, one from the latter State. The structural details of the two sexes of the southern form are represented magnified at Plate XXIX. In each figure, *a* represents the body with legs detached; *b*, a side view of the eye-eminence; *c*, a front view of the same; *d*, a side view of the palpus; and *e*, a side view of the palpal claw. The row of teeth-like tubercles on the inner border of the last joint of the male palpus do not show in the position from which the drawing was made. The engravings were made from drawings by Miss Freda Detmers.

Description.

The southern form of this species may be described as follows:

PLATE XXVIII.

Liobunum vittatum Say. Female. Mississippi.

Male.—Body 7 mm. long; 4 mm. wide. Palpi 7 mm. long. Legs: I, 44 mm.; II, 89 mm.; III, 45 mm.; IV, 64 mm.

Dorsum reddish-brown, with a dark central marking, commencing at eye eminence and extending backward to the ultimate or penultimate abdominal segment. Contracting slightly near the anterior margin of abdomen, then gradually expanding until about the beginning of the posterior third of the abdomen, where it again slightly contracts. Ventrum slightly paler than dorsum, both finely granulate. Eye eminence a little wider than high, black above, canaliculate, with small black tubercles over the eyes. Mandibles light yellowish-brown, tips of claws black; second joint with short sparse hairs. Palpi long, reddish-brown; tarsal joints paler. Femur and patella arched with two rows of rather blunt dark tubercles on the outer ventro-lateral surface; femur also having a few small subobsolete ones on its dorsal surface. Tibia with a similar row on its outer ventro-lateral surface, a short row on the distal portion of its inner ventro-lateral surface, and a short row on the proximal portion of its ventral surface. Tarsus pubescent, with a row of short, blunt, black tubercles on its inner ventro-lateral surface, extending from the base to near the apex. Legs varying from light brown to black, but patella is generally black and tarsi brown, the other joints varying. Coxæ reddish-brown, minutely tuberculate. Trochanters generally dark brown with minute scattered tubercles. Femora and patellæ with rows of small spines. Tibiæ with very short hairs. Shaft of genital organ slender, subcylindrical, not broadened distally, but bent at an obtuse angle and terminating in a very acute point.

Female.—Body 8–9 mm. long; 5–6 mm. wide. Palpi 5 mm. long. Legs: I, 42 mm.; II, 90 mm.; III, 43 mm.; IV, 61 mm.

Besides its rounder body and much more robust appearance, it differs from the male as follows: Dorsum of a much darker shade of brown with less of the reddish tint, and the ventrum paler. Second joint of mandibles with fewer hairs. Palpi shorter, more slender, with the rows of tubercles on the tibia subobsolete, and that on the tarsus entirely wanting. Legs

generally light brown, with black annulations at the articulations. Ovipositor whitish, with no dark color in the apical rings.

DISTRIBUTION.

The literature of *L. v. dorsatum* shows that this form occurs in Pennsylvania, New York, District of Columbia, Illinois and Michigan. I also have specimens before me from Iowa (Gillette), Ithaca, New York. (Comstock and Banks), Lincoln, Nebraska, (Bruner), Maine, (Harvey), South Dakota (Aldrich) and a large number collected in the central and northern counties of Ohio, as well as in Vermont and New Hampshire.

By the original describer the southern form (*L. vittatum*) is said to inhabit the southern States. Dr. Wood reports it from Texas and Nebraska, and I have already reported it from southern Illinois and Kentucky. It also occurs in southern Ohio, where it has been collected in Lawrence County, in August, 1888, and July and September, 1889, and in Warren County, where we took it during the summer of 1889. I have also received a number from Arkadelphia, Arkansas, collected in 1887; and Mr. Theodore Pergande has kindly sent me a number collected at Marshall Hall, Maryland, August 21, 1887. Prof. W. B. Alwood has added a few taken at Blacksburg, Virginia, and my brother, Howard Evarts Weed, has sent a large number from Mississippi.

NEW HAMPSHIRE COLLEGE.

WHAT IS AN "ACQUIRED CHARACTER?"

By C. C. Nutting.[1]

During the discussion of an exceedingly interesting paper on the "Heredity of Acquired Characters," read before the Biological Section of the American Association for the Advancement of Science at its recent meeting, one of the members had the temerity to confess that he was not sure that he knew the exact nature of an "acquired character;" and it was noticeable that none of the noted biologists present on that occasion accepted the implied challenge by an attempt to define the expression which constituted the basis of the debate in which they were engaged. Perhaps it seemed unnecessary to define words that have of late been so prominently and persistently before the biological world. Doubtless most of the persons present, and honesty demands that I count myself among them, felt perfectly competent to give the desired definition; but after a re-survey of the controversy, which has of late made such an unusual demand upon printer's ink, it has become evident to me that the meaning of "acquired character" is elastic to an amazing degree, capable of marvellous contraction or expansion to suit the individual needs of any and all controversialists, be they NeoDarwinian or NeoLamarckian.

But the contractibility of the term is the phenomenon most apt to excite the admiration of the unbiased observer. Weismann himself, the great founder and able exponent of NeoDarwinism, has demonstrated this contractibility along with his exposition of the continuity of the germ-plasm. He says:

"If every new character is said to be 'acquired,' the term at once loses its scientific value, which lies in the restricted use." ——"Science has always claimed the right of taking certain expressions and applying them in a special sense, and I see no

[1]State University, Iowa City, Iowa.

reason why it should not exercise this right in the case of the term 'acquired.'"[2]

"It is certainly necessary to have two terms which distinguish sharply between the two chief groups of characters—the primary characters which first appear in the body itself, and the secondary ones which owe their appearance to variations in the germ, however such variations may have arisen."

He calls the former acquired or "*somatogenic*," and the latter "*blastogenic*," and maintains that "the *somatogenic* characters cannot be transmitted," or, rather, that "those who assert that they can be transmitted must furnish the requisite proofs." "The *somatogenic* characters not only include the effects of mutilation, but the changes which follow from increased or diminished performance of function, and those which are directly due to nutrition and any of the other external inflences which act upon the body."[3]

Here, then, we have Prof. Weismann's definition of acquired characters which are not transmitted, and it would seem to be sufficiently definite. Now, note the process of contraction. Speaking of the source of the variation in the germ, he says:

"I believe, however, that they (the variations) can be referred to the various external influences to which the germ is exposed before the commencement of embryonic development. Hence we may fairly attribute to the adult organism influences which determine the phyletic development of its descendants. For the germ cells are contained in the organism, and the external influences which affect them are intimately connected with the state of the organism in which they lie hid."[4]

Professor Weismann, by the way, concedes that a *quantitative* variation of the germ is thus brought about. "I must confess

[2]Essays upon Heredity, August Weismann. Page 425.

[3]According to this definition, the increased toleration of a high temperature, shown by the bacteria in Dr. Dallinger's experiments, would be an acquired character, and that this character was transmitted was experimentally proven. In the discussion of the paper, however, Prof. Morse claimed that the toleration of unwonted temperature was due to *natural selection, pure and simple*, a position which it is not the purpose of this article to combat. A forcible illustration of the difficulty treated of in the following pages.

[4]Essays on Heredity, Weismann. Page 105.

my inability to see why this variation is not *qualitative* as well."

Are not the qualities of organs and tissues affected by external conditions, such as quality of food, temperature, etc.? What justification can be found for maintaining that the germ cell is the only cell in the body not thus affected, after having admitted that quantitative effects are thus produced? This concession of a quantitative modification of the germ cell by external conditions, acting through the soma, throws the burden of proof that *qualitative modifications are not likewise effected* entirely on the NeoDarwinian side of the controversy.

But these determining causes which "modify the phylogeny of descendants," and hence the descendants themselves, produce modifications which Professor Weismann considers "blastogenic,"[5] although expressly described as acting by external stimuli through the soma. Hence the Lamarckians cannot use any examples of the manifest of modifications brought about in this way, as, although the changes brought about are *somatogenic* by definition, they are *blastogenic* by the *a priori* NeoDarwinian argument. In other words, as soon as a somatogenic variation is inherited it is immediately relegated to the list of blastogenic variations by the NeoDarwinians.

The argument could be put in this way, according to Weismann. "The obvious means by which all inheritance of all transmitted peculiarities takes place is the continuity of the germ plasm."

Any peculiarity thus inherited is blastogenic.

Ergo, any peculiarity which is inherited is blastogenic. As soon as any character, however obviously acquired, is proven by the Lamarckians to be inherited, the NeoDarwinians complacently pronounce that character blastogenic, or not acquired. And so it comes to pass that no acquired character can satisfy the requirements of the case, if that character is so unfortunate as to be transmitted.

[5] "We have an obvious means by which the inheritance of all transmitted peculiarities takes place, in *the continuity of the substance of the germ-cells or germ-plasm*." (Weismann) P. 105.

A large number of concrete examples of this phenomenon can be found in the works of Weismann and his followers.

A cow which lost its left horn by suppuration afterward produced two calves with a rudimentary left horn in each case. The loss of the horn would certainly be supposed to be an acquired character, but this character was transmitted to two calves, and thus becomes blastogenic to suit the argument. "The loss of the cow's horn may have arisen from a congenital malformation,"[6] and is, therefore, not an acquired character. How a malformation, *due to suppuration*, can be *congenital* is a question not at all considered. The needs of the NeoDarwinian school demand that this malformation be congenital, and therefore a congenital malformation it is.

The young pointer dog, untrained and without any example to imitate, springs forward, barking, at the first report of a gun. "This," say the Lamarckians, "is surely the inheritance of an acquired character;" but, no:—The dog has simply "inherited a reflex mechanism, which impels him to start forward on hearing a report,"[7] instead of running away at full yelp as a common cur would do.

A cat was said to have lost her tail by a cart running over it, and her progeny were tailless. This would seem to be a clincher, but "they, (the rudimentary tails) might have been transmitted from the unknown father."[8]

A soldier loses his left eye by inflammation fifteen years before marriage, and afterward has two sons with defective left eyes. A case of inheritance of an acquired character? Not a bit of it. "The soldier did not lose his left eye because it was injured, but because it was predisposed to become diseased from the beginning!"[9]

A boy's thumbs are malformed by chilblains, associated with some skin disease. Two of his children and two grandchildren have malformed thumbs on both hands. Here we would feel reasonably certain that our search for an acquired

[6]Essays on Heredity. (Weismann) P. 82.

[7]Essays on Heredity. (Weismann) Page 94.

[8]Essays on Heredity. (Weismann) Page 439.

[9]Essays on Heredity. (Weismann) Page 451.

character has been at last rewarded; but no;—"A high degree of susceptibility of the skin of the thumb was obviously innate in the father, and this "*susceptibility*" was what was "certainly transmitted, and led to the similar malformation of the thumbs of the children."[10]

Artificially produced epilepsy in guinea pigs was inherited by the descendants to the fifth generation, but, "it is easy to imagine that the passage of some specific organism (from the lesion made by the division of the sciatic nerve!) through the reproductive cells may take place."[11]

Westphal produces inheritable epilepsy by blows upon the head, and Ziegler asks if the guinea-pigs operated on "may not have been already predisposed to disease?"[12]

But enough examples have been given to demonstrate that acquired characters, however evident they may be to all but the NeoDarwinians, have the convenient property of becoming blastogenic, or not acquired, whenever they are proved to be transmitted.

To what, then, shall we liken an acquired character? To an unstable chemical compound, a vanishing quantity, a will-o'-the-wisp, a name to conjure with! And the Neo-Lamarckians are but children chasing rainbows, which are conjured away in smiling complacency by the wise NeoDarwinians of this generation.

[10]Essays on Heredity. (Weismann) Page 451.

[11]Essays on Heredity. (Weismann) Page 82.

[12]Organic Evolution. (Eimer) Page 182.

EDITORIALS.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

—The Association of Colleges in New England is taking a good step in its discussion of the following proposed changes in the courses of study in the grammar schools:

1. The introduction of elementary natural history into the earlier years of the program as a substantial subject, to be taught by demonstrations and practical exercises rather than from books.

2. The introduction of elementary physics into the later years of the program as a substantial subject, to be taught by the experimental or laboratory method, and to include exact weighing and measuring by the pupils themselves.

3. The introduction of elementary algebra at an age not later than twelve years.

4. The introduction of elementary plane geometry at an age not later than thirteen years.

5. The offering of the opportunity to study French, German, or Latin, or any two of these languages from and after the age of ten years.

As it has been in the past, the whole course of instruction in the much-praised New England common schools has been such as to repress the individuality and to discourage the observational powers of the pupil. The curriculum has apparently been devised to teach a lot of difficult arithmetical puzzles of no practical value and to encumber the young minds with a lot of abstruse grammatical rules which they must learn, parrot-like, but which they cannot understand until they are more mature. So to gain time for these new subjects, surely as valuable to the ordinary person as cube root or the rules of prosody and the definition of "a conditional, subjunctive, dependent sentence," it is proposed to take from the time usually allotted to arithmetic, geography, and grammar.

That the change will be made without considerable opposition is not to be expected, for the present teachers of our grammar schools are not prepared to teach by the observational method. Were it merely demanded that the instructor should hear the students repeat by rote the statements in some trashy "Fourteen Weeks" text book, there would be little trouble. They could handle that as they do the

drunkard-stomach physiology; but experimental work demands more training and more brains. The new curriculum demands better trained teachers, it provides more practical information for the student; and when we remember that the majority of our children leave their schools behind at the close of the grammar school grade, the necessity of some such change as that here outlined is self evident.

This subject of increase in the scope of our lower schools is attractive, and when upon it one scarcely knows where to stop. Custom and incompetency have forced so many things upon us and inertia so maintains them as they are that a change is a matter of the greatest difficulty. Yet everyone who has studied carefully even the so-called pattern schools of the larger cities of Massachusetts sees that they occupy an enormous amount of time with ridiculously small results. They regard the infantile mind as so much plastic material which must be pressed into a conventional mold and the time necessary for this shaping is regulated by that of the dullest intellects. The children are drilled in the spelling of words like phthisic, and eleemosynary, which they will never have occasion to use until they arrive at years of maturity, and they are kept at the simple problems of addition and multiplication until they are perfect in them, utterly regardless of the fact that this perfection is to be obtained only through practice, and that this practice is to be had in abundance in all the subsequent arithmetical work. Time enough can be gained right here for the insertion of some observational science without the omission of a single useful principle or fact.

Whether it is actually so, or whether it is one of the fictions of our national pride, we are given to regarding the youth of the United States as intellectually the equals of those of any other nation, but it is a mortifying fact that when we compare our children with those of an equal age trained in the schools of Germany and France ours are the sufferers. These foreigners know more things and they know them more thoroughly. They have, at the close of the grammar school grade, not only a knowledge of the "three R's," but they have a grounding of at least one language, and they know besides, the elementary principles of several sciences. The writer believes that with proper instruction our children can equal them, even with our absurdly difficult orthography, and he welcomes this step on the part of the Association as in the right direction.

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RECENT LITERATURE.

The Speech of Monkeys.[1]—For a number of years Mr. R. L. Garner has been engaged in a series of observations and experiments with a view of proving the truth of his theory that monkeys possess an articulate language comparable with that of man. Thinking that his investigations may be of interest and perhaps induce others to take up a similar line of work, he has published in a small volume of 217 pages a report of his progress. The author first gives in detail a number of experiments to illustrate his method, and secondly, a definition of speech followed by the deductions made from his experiments.

Mr. Garner's general plan of procedure is to obtain phonographic records of sounds made by monkeys under varied stimuli. These records were studied with care by Mr. Garner until he could recognize and perfectly imitate many. Having accomplished this the next step is to repeat the sound to the monkey and observe its effect on its action. In this way Mr. Garner has determined with a fair degree of certainty nine sounds used by the Capuchins, and also the sound for food, and the sound of alarm in the Rhesus dialect. The following is one of many experiments to decide the meaning of the sound supposed to mean milk in Capuchin language:

"On one of my visits to the Chicago garden I stood with my side to a cage containing a small Capuchin, and gave the sound which I have translated "milk." It caused him to turn and look at me, and on repeating the sound a few times he answered me very distinctly with the same, picking up the pan from which he usually drank, and as I repeated the word he brought the pan to the front of the cage, set it down and came up to the bars, and uttered the word distinctly. I had not shown him any milk or any kind of food; but the man in charge, at my request, brought me some milk, which I gave to him. He drank it with great delight; then looked at me and held up his pan, repeating the sound. I am quite sure that he used the same sound each time that he wanted milk. During this same visit I tried many experiments with the word which I am now convinced means "food" or "hunger."

[1]The Speech of Monkeys, by R. L. Garner, in two parts. New York, 1892. Charles L. Webster & Co., publishers.

Another experiment, satisfactory in its results, tested the sound for alarm or assault. Mr. Garner gives the account as follows:

In Charleston a gentleman owns a fine specimen of the brown Cebus. This monkey is naturally shy of strangers, but on my first visit to him I addressed him in his native tongue, and he really seemed to regard me very kindly; he would eat from my hand and allow me to caress him through the bars of the cage.

He eyed me with evident curiosity, but invariably responded to the word that I uttered in his own language. On my third visit to him I determined to try the effect of the peculiar sound of "alarm" or "assault," which I had learned from one of this species; but I cannot very well represent in letters. While he was eating from my hand I gave this peculiar piercing note, and he instantly sprang to a perch in the top of his cage, thence in and out of his sleeping apartment with great speed and almost wild with fear. As I repeated the sound his fears seemed to increase, until from a mere sense of compassion I desisted. No amount of coaxing would induce him to return to me. I retired to a distance of twenty feet from his cage, and his master induced him to descend from the perch, which he did with the greatest reluctance and suspicion. I gave the sound again from where I stood, and it produced almost the same results as before.

Mr. Garner gives numerous other illustrations of his methods and furnishes a summary of his observations as follows:

The sounds which monkeys make are voluntary, deliberate, and articulate. They are always addressed to some certain individual with the evident purpose of having them understood. The monkey indicates by his own acts and the manner of delivery that he is conscious of the meaning of the sounds. They wait for and expect an answer, and if they do not receive one they frequently repeat the sounds. They usually look at the person addressed, and do not utter these sounds when alone or as a mere pastime, but only at such times as some one is present to hear them, either some person or another monkey. They understand the signs made by other monkeys of their own kind, and usually respond to them with a like sound. They understand these sounds when imitated by a human being, by a whistle, a phonograph or other mechanical devices, and this indicates that they are guided by the sounds alone, and not by any signs, gestures, or psychic influence. The same sound is interpreted to mean the same thing and obeyed in the same manner by different monkeys of the same species. Different sounds are accompanied by different gestures, and produce different results under the same conditions. They make

their sounds with the vocal organs, and modulate them with the teeth, tongue and lips. The fundamental sounds appear to be pure vowels, but faint traces of consonants are found in many words, especially those of low pitch.

The experiments made by Mr. Garner have been conducted in an ingenious and careful manner, and his results appear to be of value to science. He has the spirit and capacity of the original investigator, and his researches are of much interest to the specialist as well as to the general reader. It is when he turns to the large questions outside of his immediate field of research that it is evident that he has not yet mastered the achievements of human thought. This he will probably do in future, as he has a clear idea of the problems involved. A judicious use of the scissors would have benefited the latter half of the book as it is.

Mr.Garner has gone to Africa with the phonograph with the intention of recording the voices of the gorilla and chimpanzee. It may be questioned whether these animals will be as amenable to social intercourse in the wild state as they are when confined behind the bars of a zoological garden. The gorilla, especially, will not treat with the respect they deserve Mr. Garner's efforts to engage in conversation. We, however, wish him success in his enterprise, not only with regard to these, our distant relations, but also our nearer of kin, the Africans of the native tribes.

Elementary Biology.[2]—A book written by a teacher for students. The general plan of the work is to familiarize the student with ideas through the medium of facts. In the author's opinion these ideas are best understood when arrived at by the study of concrete types of animals and plants. The types chosen to illustrate a particular grade of organization must be simple. In view of this last principle considerable attention is given to the Protozoa; only a brief reference is made to Hydra and to the sexual process in Penicillium; Nitella is described instead of Chara, and Polygordius instead of the earthworm. In the chapter devoted to the higher groups of animals and plants brief descriptions of types are given in terms of Polygordius and the Fern respectively. As occasion offers special lessons on such subjects as biogenesis, evolution, origin of species, etc., are introduced in order to give a fairly connected account of the general principles of biology.

[2]Lessons in Elementary Biology, by T. Jeffery Parker, B. Sc., F. R. S., professor of biology in the University of Otago, Dunedin, New Zealand, with eighty-nine illustrations; Macmillan and Co., London and New York, 1891.

To us it seems as if the above plan, while admirable in some respects, was open to criticism. Polygordius, for instance, is a simple annelid, and whether that simplicity is primitive or results from degeneration is of secondary moment in a text book of this sort. Our objection would rather rest upon the fact that the worm is not widely distributed and is infrequent, at least in American waters, while the inland student must entirely forego its use in his laboratory work. On the other hand it is well to have this presentation of the features of this simple worm, for it is usually slighted in our text books and in the most recent one, Hertwig's Lehrbuch, it and the group to which it belongs are entirely ignored in the text.

The numerous illustrations are, for the most part, original, and each plate is fully described instead of having appended a mere list of reference letters. A synopsis, an index, and a glossary complete the work.

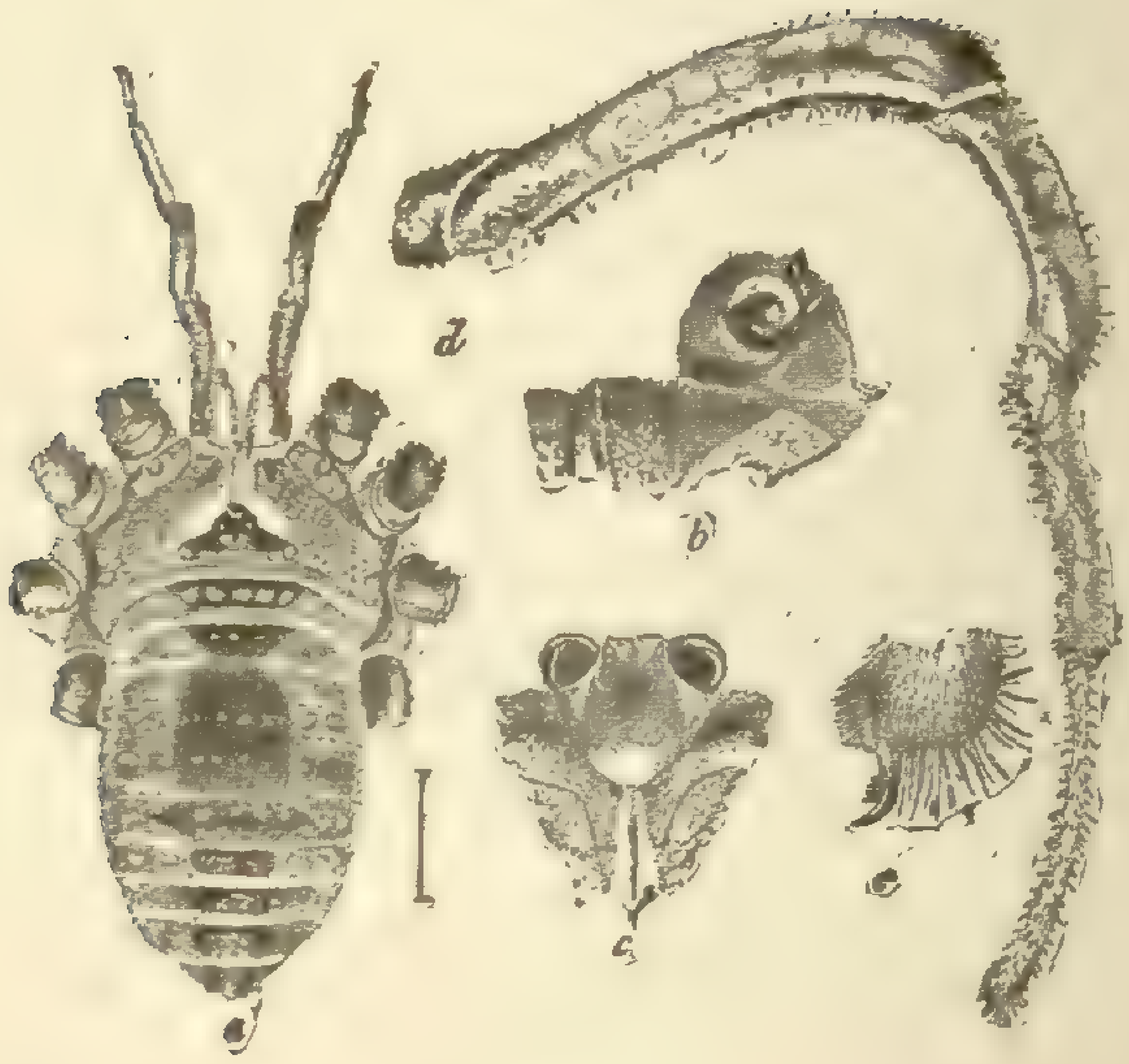
Apgar's Trees of the Northern United States.[3]—The plan of this little book is well indicated in one of the paragraphs in the preface. The difficulty in tree study by the aid of the usual botanies lies mainly in the fact that in using them the first essential parts to be examined are the blossoms and their organs. These remain on the trees a very short time, are often entirely unnoticed on account of their small size or obscure color, and are usually inaccessible, even if seen. In this book the leaves, the wood, the bark, and, in an elementary way, the fruit, are the parts that must be thoroughly known by all who wish to learn to recognize trees. Its purpose is to place before pupils in the public schools an easy manual of our common trees in the hope that the trees of our forests, lawns, yards, orchards, streets, borders, and parks may not continue to be neglected—a most commendable endeavor, indeed.

Doubtless if our teachers of botany in the public schools had anything like an adequate knowledge of the subject such a book would not be called for, but as Prof. Apgar somewhat sarcastically remarks, "this book was written for the average teacher who has had no strictly scientific training." It is to be hoped that it will serve the purpose intended by its author, and that the next generation of high school graduates, all of whom have "done botany, of course," will know

[3]Trees of the Northern United States, their study, description and determination; for the use of schools and private students, by Austin C. Apgar, professor of botany in the New Jersey State Normal School. Small, 8 vol., 224 pp. American Book Company, 1892.

PLATE XXIX.

Fig. 1.

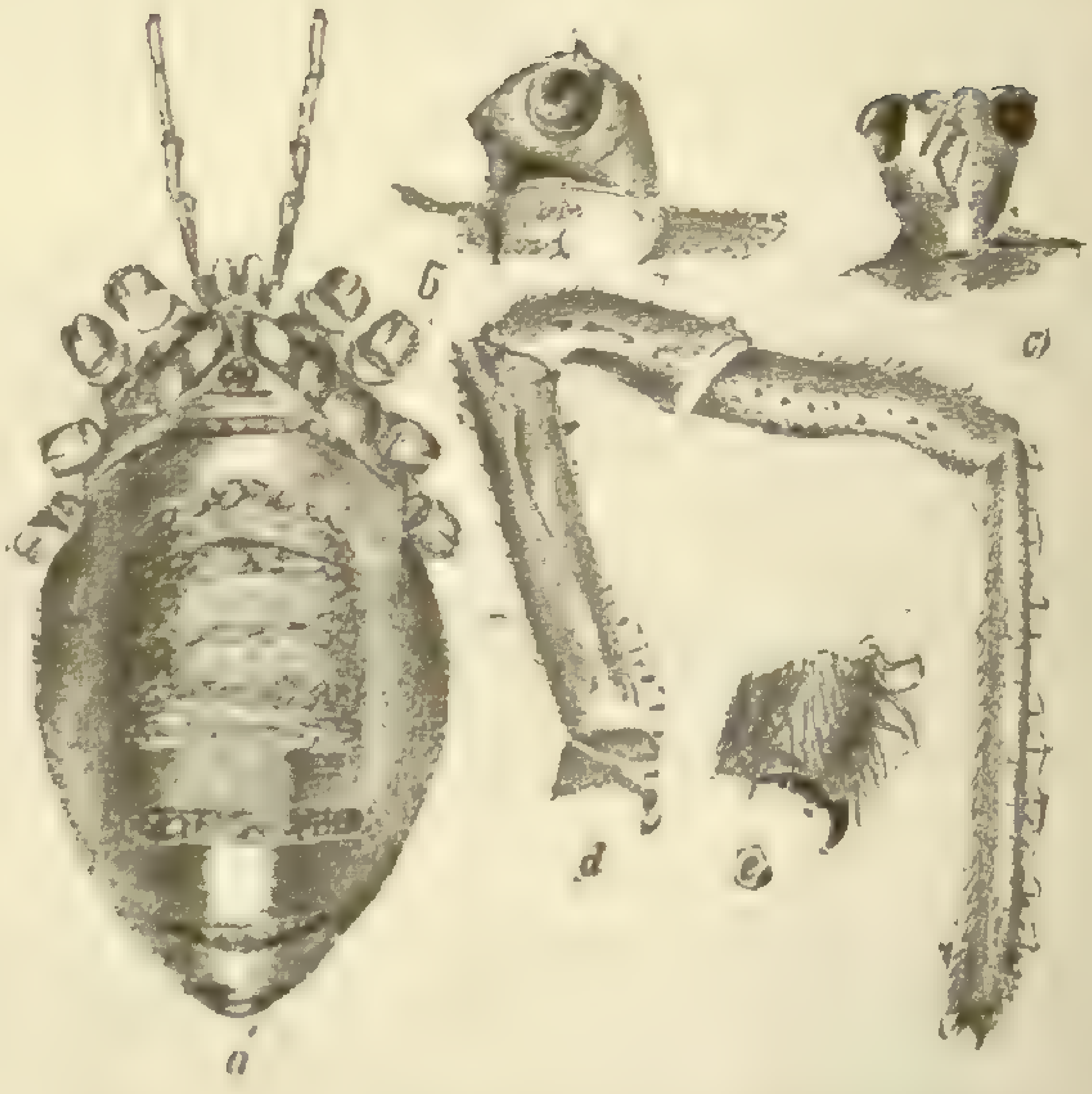


Male.

Fig. 1.

Liobunum vittatum dorsatum. Male.
Dakota.

Fig. 2.



Female. *Liobunum vittatum Say.*

something of our common trees. It can be heartily commended to horticulturists, gardeners, and non-botanical tree planters.

The illustrations are helpful, and are apparently quite accurate. The nomenclature is strictly that of the latest edition of "Gray's Manual," an error of judgment which can easily be corrected in a subsequent edition.—CHARLES E. BESSEY.

Bailey's Rule Book.[4]—Although not strictly a botanical work, this little book contains a good deal of botany, and very good botany, too. It should be in the teacher's library, in the public schools, where nearly every chapter, non-botanical as well as botanical, will be instructive. The chapters on Plant Diseases, Fungicides, Weeds, and Moss, Seed Tables, Collecting and Preserving, Names, Histories, and Statistics, are those dealing more especially with botanical topics. Under the first-mentioned topic are given in summary form such descriptions of the general appearance of many of the fungi parasitic upon common plants as will enable anyone to recognize them. For horticulturists this chapter will be most helpful, but it will be scarcely less so for many a teacher of botany who is obliged to get on with a small library, especially as to works on the fungi.—CHARLES E. BESSEY.

Brehm's Thierleben, Kriechthiere und Lurche.[5]—The third edition of this well-known work, under direction of Professors Oscar Boettger and Pechuel Loesche, brings it up to the present date and adds to its previous well-earned reputation. The authors, as was to have been expected, dwell relatively more upon European species than upon those exotic to that country, but the small number of these does not materially disturb the balance of the book except in the department of the true Salamanders, where but one non-European species is figured. The descriptions of the habits of reptiles and batrachians are derived from the best sources, and indeed this work is the only one which is comprehensive and modern in this department, which may be regarded as trustworthy. The illustrations, from the incomparable pencil of Mützel, are the best ever offered to the public in so cheap a

[4]The Horticulturalist's Rule Book, a compendium of useful information for fruit growers, truck gardeners, florists, and others, completed to the beginning of the year 1892, by L. H. Bailey. Second edition revised. 12mo., 215 pp. Rural Publishing Co., N. Y.

[5]Dritte gaäzlich neuaubeitete Auflage; herausg. v. Prof. Pechuel Loesche. Kriechthiere u. Lurche, neubearbeitet von Prof. Dr. O. Boettger u. Prof. Dr. Pechuel Loesche. Leipzig u. Wien Bibliogr. Inst., 1892.

form. The name of Dr. Boettger, of Frankfort a. M., guarantees the scientific accuracy of the treatment. We only notice that he has allowed the *Heloderma suspectum* to be figured as *H. horridum*, and that *Cyclura nubila* to be figured as *C. carinata*. A peculiarly effective picture is the chromo-lithograph representing a species of Draco capturing a butterfly in a tropical forest, with an orchid full of bloom in the foreground, all presenting mimetic colors, and relieved by a background of the symmetrical leaves of a Musa. We reproduce two of the plates, the alligator-crocodile of West Africa, and the snake-necked turtle of the La Plata.

Some interesting comments are made on the abundance of and danger from venomous snakes in tropical countries. It is pointed out that travelers agree that these animals do not constitute a serious obstacle to the comfort and safety of travel in those regions. The author of this work believes that the official reports of deaths from venomous snakes in India are gross exaggerations. If true, he observes, that as compared with snakes, tigers and wolves are harmless creatures. He also believes that in order to obtain the bounty paid for venomous snakes by the Indian Government, a number of establishments for breeding them must be kept in active operation by the natives. None of the citations from travelers indicate a greater abundance of poisonous snakes in tropical countries than we have ourselves observed in the central and southwestern parts of North America.

General Notes.

GEOLOGY AND PALEONTOLOGY.

American Devonian Fishes found in Belgium.—An examination of M. Lohest's collection of Devonian fishes at Liege by Mr. Newberry has brought to light the following interesting facts:

Among the specimens collected in the macignos of Ouppet near the upper part of the sands of Condroz, Mr. Newberry recognized the bony plates of the head of a fish of the genus Dinichthys, which, until now, was found only in America. The genus Dinichthys was created by Newberry for a gigantic fish, with a head a meter in length, having the body like that of Coccosteus covered with bony plates.

Of the specimens recognized by Newberry one was referred to *D. pustulosus*, while the others seemed to be closely allied to the American species, *D. terrilli*.

These fossils were found at Ouppet in a calcareous macigno rock, associated with *Spirifer disjunctus* and also with the palatine teeth of Dipnoans, of which two species, *Dipterus flabelliformis* and *D. nelsonii*, are American types.

The paleontological interest of the presence of Dinichthys in the Devonian of Belgium is increased by the fact that in America these huge creatures are found in a rock analogous to that of Ouppet, associated with the same *Spirifer* and the same *Dipterus*.

In America, also, these fossils are found in a Chemung stratum which is separated from the Lower Carboniferous by a bed of Catskill sandstone containing *Holoptychius americanus*, a species related to the Holoptychius of the famennien of Belgium.

Another Devonian fish described by M. Lohest and referred by him to the genus Bothriolepis, was found near Chèvremont. The fossil shows the head, the swimming organs, and the dorsal plates. It appears to be closely related to *B. canadensis* from the Upper Devonian of Scammenac Bay, Canada.

The discovery in the sands of Condroz of species closely related, if not identical, with American species, confirms the view now generally adopted as to the famennien age of the Chemung and Catskill beds.—Ann. Soc. Geol. de Belgique, Tome xvi.

The Geology of Borneo.—Posewitz treats of the geology of Borneo under four heads: (1) The Mountain-land; (2) The Tertiary Hill-land; (3) The Drift of the Plains; (4) The Alluvium of the Marshes.

The mountain-land consists of crystalline schists, old eruptive rocks, and a slate formation that may be Devonian, overlaid by a carboniferous formation of hard, bluish limestone, succeeded by coarse white sandstones. This carboniferous formation is clearly marked off from the tertiary beds that succeed it.

Cretaceous rocks have been discovered in West Borneo by Van Schelle, the fossils of which have been referred by Geinitz to the Upper Chalk.

The hill-land forms a belt around the mountain-land. It rises into hills (Eocene) near the mountain border and dies away into the common level of the plains (Miocene).

Verbeck divides the Eocene of Borneo into three stages: (a) Sandstone, (b) marl, and (c) the limestone. Of these the sandstone stage is the most important since it contains the Borneo black coal. The marl stage is very fossiliferous, one bed being literally packed with Orbitoides and Nummulites. The limestone stage appears to be the equivalent of the Nummulitic Limestone of Europe.

The eocene strata are pierced in numerous places by the eruption of andesitic lavas probably of miocene age. These lavas are bedded and accompanied by tuffs. Above the andesites lie a series of shales and limestones described by Verbeck as miocene.

The drift of the plains forms a zone round the hill-land, and also covers the flanks of the mountains. It contains the chief deposits of gold, platinum, and diamonds.

The alluvium of the marshes has a wide distribution, owing to the very gradual rise of the land from the coast.

Wallace regards the Malay Archipelago as having been produced by the breaking up of a continental area; Posewitz, on the contrary, describes Borneo as resulting from the fusion of an archipelago of small islands, the grouping of which has been preserved in the main features of the present structure.—Natural Science, April, 1892.

Phosphates and Marls of Alabama.—The interest in the natural fertilizers of the State of Alabama has led Mr. E. A. Smith, the State geologist, to publish a separate bulletin upon the subject in advance of the general report upon the cretaceous and tertiary formations.

The subject is treated with the characteristic thoroughness of the author. The geological age, mode of occurrence, composition, and probable origin of the phosphates are given, followed by remarks on the calcareous marls. The paper closes with a dissertation on the economical relations of the phosphates. Phosphatic marls have been found at the base and summit of the rotten limestone of the cretaceous formation, and in the lignitic, white limestone and Claiborne group of the tertiary. They are not of so high grade as those of South Carolina, but resemble more nearly those of New Jersey. This the author considers to be advantageous to the State. If they are not rich enough to export there is more probability of their use at home; and the enhancement in the value of the lands and the increase in the crops due to their use will represent a larger amount of capital than would the trade in the exported rock.

Keyes' Mississippian Section.—Mr. Charles Keyes substitutes the term Mississippian for Lower Carboniferous as applied to certain rocks of the Mississippi Valley, and tabulates them as follows:

Mississippian Series.	Kaskaskia group.........	Chester shales.
		Kaskaskia limestone.
		Aux Vases sandstone.
	St. Louis group.........	Ste. Genevieve limestone.
		St. Louis limestone.
		Warsaw limestone (in part; not typical).
	Osage group..............	Warsaw shales and limestone.
		Geode bed.
		Keokuk limestone.
		Upper Burlington limestone.
		Lower Burlington limestone.
	Kinderhook group	Chouteau limestone.
		Hannibal shales.
		Louisiana limestone.

Bull. G. S. A., Vol. 3, 1892.

Geology of the Crazy Mountains.—A description recently published by J. E. Wolff gives some interesting features of the Crazy Mountains of Central Montana. They form an isolated range of the Rocky Mountains rising to the height of 11,000 feet above sea level. A branch of the Yellowstone River has cut a transverse valley, dividing the range into northern and southern halves.

The range lies in a region of nearly horizontal cretaceous rocks. The southern half is characterized by a basin structure, the interior of which is interrupted by dome-shaped uplifts of dioritic stock. The

dioritic stock as well as the adjacent cretaceous rocks, are cut by later vertical dykes having a general radial arrangement with the dioritic mass as an approximate center. In the northern half longitudinal uplifts produce long-crested ridges. The eruptive rocks, like those of the southern area, are younger than the enclosing strata. The dykes are innumerable; in one place a dyke was counted every fifty feet horizontal on a long spur.

The great masses of crystalline rock and the honey-combing of the soft strata by dykes has enabled this range to resist the erosion which has levelled the adjoining country and made it what Warren Upham calls a good example of "an eroded mountain range."—Bull. A. G. S., Vol. 3, 1892.

Geological Survey of New Jersey, 1891.—The work accomplished by the State Geologist and his assistants during the past year is reported by Mr. Smock as follows:

A study of the surface or pleistocene formations of the northern part of the State, by Prof. Salisbury; (2) an examination of the oakland and pine-land belts of the State, by C. W. Coman; (3) a continued study of the water-supply and water-power, and (4) in co-operation with the United States Geological Survey, a study of the crystalline rocks of the highlands of northern New Jersey.

Some notes on the active iron mines and on artesian wells have been collected.

Numerous maps and charts accompany the report.

A Hyena and Other Carnivora from Texas.—At a meeting of the Philadelphia Academy Prof. Cope stated that he had during the past season while exploring the eastern front of the Staked Plains of Texas with the party of the Geological Survey of that State under Prof. W. F. Cummins, obtained the remains of some interesting carnivora from the Blanco or Pliocene beds. One of these is a hyena nearly allied to the genus Hyæna, and the first species of this family found in America. It, however, differs from the typical genus in having a fourth premolar in the lower jaw, and probably in having a shorter blade of the sectorial tooth in the upper. He proposed the name Borophagus for the genus, and for the species the name *diversidens*. The third lower premolar is very large and robust, greatly exceeding the fourth in dimensions. The latter is low and molariform; the inferior canine is large. The measurements are as follows: Transverse diameter of canine alveolus, 13 mm.; do. of posterior alveolus of pm.

iii, 13 mm.; diameters of pm. iv; longitudinal 4 mm.; anteroposterior, 10; transverse, 8. Diameters of pm. iii; longitudinal, 17 mm.; anteroposterior (partly restored), 28; transverse, 15. The species is as large as the spotted hyena, and was the scavenger of the Blanco Fauna.

Another interesting carnivore is a weasel of a new genus and species, which it was proposed to call *Canimartes cumminsii* after its discoverer. The genus *Canimartes* is allied to *Mustela*, differing only in the presence of two superior true molars. Metaconid of inferior sectorial well developed; talon of the same trenchant. The species is as large as the fisher.

A third carnivore is a cat, provisionally referred to the genus Felis under the name of *F. hillianus*, after Prof. Robert T. Hill, the well-known geologist. This cat is about the size of the cheetah, and has large canine teeth without grooves, and the feet are shorter than in modern cats.—E. D. Cope.

Geological News, General.—Mr. Hilgard's notes on the Cienegas of California show them to be of considerable economic importance. A cienega is a limited area showing a growth of water-loving plants, appearing sporadically in otherwise arid surroundings. Observation shows this area to be a débris fan or cone, having its apex near the mouth of a cañon. The débris consists of alternate deposits of rounded gravel and cobble, fine silt, and even clay. These deposits form a natural storage reservoir for the flood waters of the cañon, annually replenished, provided an open cobble surface is maintained at the apex of the cone. The conditions necessary for cienega formation are fulfilled in the granitic ranges of southern California.

Lee Lake, which furnishes the water supply of the "South Riverside" colony in the Valley of Temescal Creek is an exemplification of the value of the Cienega formations. This lake is fed entirely by an almost continual ooze from the masses of débris that have accumulated in front of the two uppermost cañons of the Temescal Valley.—Bull. Geol. Soc. Am., Vol. iii.

Archean.—The conclusions reached by Mr. N. H. Winchell in regard to the occurrence and distribution of the Mesabi iron ore of Minnesota are that no theory has yet been proposed that is satisfactory, and the one cause acting with sufficient force on a geographical area sufficiently wide to which appeal can be made for the geographic and stratigraphic distribution of this ore, is *oceanic sedimentation*.—

Am. Geol., Sept.. 1892.—Prof. F. W. Hutton is inclined to think that the Foliated rocks of Otago belong to the archean rather than the paleozoic era. The absence of plication and of cleavage oblique to the stratification throughout the district are sufficient proofs that the foliation is not due to crushing or dynamic metamorphism, while it cannot be considered as a region of contact metamorphism, for the only eruptive rocks are those near Queenstown, and they have been foliated along with the rest. The metamorphic action would, therefore, appear to be due to the internal heat of the earth at a very early period of its history, when the temperature gradient was much steeper than it is now.—Trans. New Zealand Inst., Vol. xxiv.

Paleozoic.—In his notes on the Devonian Fish-Fauna of Spitzbergen, Mr. A. Smith Woodward confirms the views published by Prof. Lankester that two distinct horizons—an upper and a lower—are recognizable in the Devonian formation of Spitzbergen.—*Ann. and Mag. Nat. Hist.*, 1891.——Mr. Walcott has obtained data which establish the fact that during the Middle Cambrian there was an immense deposition of sediments that now form a series of shales and limestones nearly 3000 feet in thickness. The fauna of Middle Cambrian time in Tennessee is essentially the same as that of the basal deposits about the Adirondack Mountains, the upper Mississippi Valley areas of Wisconsin and Minnesota, those about the Black Hills of Dakota, and the Llano Hills of Texas.—*Am. Jour. Science,* July, 1892.——Mr. C. A. White agrees with Mr. T. W. Stanton in his conclusion that the Bear River formation is not equivalent to the Laramie, but that it occupies a position beneath the greater part of the equivalent of the Colorado formation of the marine cretaceous series.—*Amer. Jour. Sci.*, Vol. xliii.——Paleontologists are indebted to W. H. Sherzer for a monograph of the genus Conophyllum. So vague have been the old definitions of the genus that in the ten species thus far assigned to Conophyllum there are at least five different genera represented.—Bull. G. S. Am., Vol. iii, 1892.

Mesozoic.—A Cretaceous Flora has been discovered in the Holma sandstone, southern part of Sweden. The fossils consist of silicified trunks in place, some small twigs and well preserved pine cones. Two of the species discovered are new, and have been named *Pinus nathorstii* and *Cedroxylon ryedalense*. Dr. Conwentz has fully described both their external characters and their internal structure in a paper recently published in Kongl. svenska Vetenskaps Akademiens.——Mr. Dumble includes under the name Reynosa a series of deposits

occurring in Western Texas and extending into Mexico. They overlie the Fayette sands and consist of gravel cemented by a very porous tufaceous limestone. In some places only the limestone is present. It contains such fossils as *Bulimus alternatus* Say, and seems to be in part the equivalent of the Equus beds of southwestern Texas described by Leidy and Cope.—Bull. Geol. Soc. Am., Vol. iii, pp. 219–230.——Part 4 of Contributions to Canadian Micro-Paleontology has been published by the Canadian Geological Survey. It consists of descriptions and illustrations of thirteen new and three previously known species of Radiolaria from the upper cretaceous rocks of northwestern Manitoba. The report was prepared by Dr. D. Rüst, of Hanover, Germany, who has made a life study of fossil Radiolaria.

Cenozoic.—A fine series of mandibles of *Phascolomys mitchelli* in the Queensland collection supports the view of Mr. DeVis that *P. mitchelli* and *P. platyrhinus* are distinct species. The same writer also affirms that *Sceparnodon* is not a synonym of *Phascolonus*, basing his assertion upon a study of the upper and lower incisors of *Sceparnodon*.—Proceeds. Linn. Soc. N. S. W., Vol. vi.——Mr. Lydekker has recently described and figured a Sirenian Jaw from the Oligocene of Italy. Some peculiarities of dentition appear to him to point clearly to an Artiodactyle ungulate ancestor with short crowned and selenodont molar teeth. This presumed origin has been urged by zoologists, but until now there has been no accepted proof of their derivation; nor is it likely that any such will ever be found.—Proceeds. London Zool. Soc., 1892.——The discovery in Queensland of a second species of Owenia establishes the validity of that genus. Mr. C. W. DeVis proposes, since the name *Owenia* is preoccupied, to substitute for it the name Euowenia.—Proceeds. Linn. Soc., N. S. W., Vol. vi.——According to Lydekker *Viverra hastingsiæ*, described by Mr. Wm. Davies, from the upper eocene of Hordwell, is specifically inseparable from *V. angustidens*.—Quar. Jour. Geol. Soc., Aug., 1892.

BOTANY.

Development of the Floral Organs in Aster and Solidago.—The point of growth of the shoot axis becomes very much retarded, and as a result the growing point is transformed into a broad, somewhat elevated disc on which are to appear flowering capitula with centrifugal inflorescence.

The first structure indicating an individual embryonic flower on the receptacle is a hemispherical outgrowth almost perfect in outline and becoming obconical as growth takes place. This embryonic tissue standing on a lateral axis, constitutes the foundation from which arises a differentiation of tissue into special organs. Thus far the path of embryonic development remains the same for all organs, even those of the most various kind. So we have the law of greater structural similarity well worked out in the earlier stages of organisms. From this condition of things on, a new departure is made; the apex of the broad flower axis ceases to grow, while the peripheral portion continues to develop; here we have the first hint of the initial growth of true floral organs. A tubular ring is thus formed and on its peripheral wall small papillæ rapidly arise, giving the structure a cup-shaped appearance with a shallow depression and scalloped margin. This so-called cup elongates, its sinus grows deeper, and the five corolla lobes become sharply defined and are known at once by their shape. Simultaneously with the development of the floral organs in the rising ring, in which there is a complete fusion of all flower parts until liberated, a deep central depression is forming, when ultimately the ovule-bearing portion is placed beneath the rest of the flower parts. Thus we have an epigynous flower with an inferior ovary. However, there are some who would substitute the word hypogynous for epigynous, basing their argument on the theory that all the floral organs, in their initial state, are coalesced in the annular wall; that the appearance of each is due to the liberation of their uppermost parts; that each whorl may appear either in acropetal, or certain whorls, seemingly basipetal, order. The real origin and behavior of the floral organs in their younger stages of development as correlated with the inferior ovary has attracted but little attention, and, therefore, no definite statement can be made as to the true relationship existing between the floral organs in their embryonic condition.

Turning now to the order of development of flower parts, the first foliar structure that appears is a petal. At first they appear as small papillae on the annular wall. In their further development the tissue thickens and the epidermal cells with their rather heavy cell walls become quite large; in later growth their tissue becomes more uniform, and the tips of the five marginal teeth of the corolla-tube turn inward, thus furnishing an excellent protection to the andrœcium and gynœcium. The petals forming the flower tube are not simply contiguous but united, and as the tube elongates it assumes, slightly, the form of a funnel whose upper margin has five spreading teeth. The tubular corolla is not composed of parts originally separate and subsequently united by their lateral margins, for the parts set free are the marginal teeth arising from a common basal tissue; and this tissue develops and elongates *pari passu* with the growth of the nascent organs within.

Almost immediately following the visible corolla, appearing on its inner basal margin, are five minute elevations, the rudimentary stamens. These develop with remarkable rapidity, and their primitive, oval form is soon exchanged for one that is oblong. The histological constituent of the stamen in its early growth is a mass of uniform parenchyma. Presently a new condition arises; a differentiation of tissue into anther lobes and a connective takes place. The fibro-vascular bundle, which is a continuation of that of the flower-axis, though very much reduced, differentiates in the upper part of the stamen, and forms the so-called connective. At the same time there is a modification of tissue which develops into anther lobes; these are connected and yet separated by the connective. In the early process of growth there appear two longitudinal ridges on each half-anther lobe; these answer to the future pollen sacs, and give rise to the archesporium cells, which, usually having but one row in each pollen-sac, again give rise to the squarish mother-cells; in turn the latter yield four pollen grains each. The developmental path, pursued by all pollen grains, is so common that space is of more avail than their further treatment. To give a more complete account of stamineal tissue, mention also should be made of the anther tube. At first the filament develops slowly and the stamens are distinct from one another, but just preceding the unfolding of the flower bud the filament gains length at a very rapid rate by the elongation of its cells; finally the lateral edges of the anthers become coalescent, thus forming a tube, which, when the flower is fully developed, projects beyond the tubular corolla. The anthers do not simply cohere, but unite, for cross sec-

tions show the blending of epidermal tissue; this makes the union complete.

Simultaneously with the origin and development of the stamen, another structure comes into view—the calyx. When first observed there is a bulging out of the epidermal layer in the region of the seeming insertion of the other floral parts. The tube of this outgrowth is not distinguishable from the ovarian wall, but its limb is visible as a tuft of hairs. Primitively, it consists of a short, delicate bunch of hairs, arranged in a circle at the upper extremity of the young ovary. Later, the hairs by rapid growth develop into long appendages, made up of several rows of narrow but extremely elongated cells, the lower ends of which splice into the upper ends of the cells below at the point where the upper end of the cells below turn away from the main trunk, and rapidly taper into an acuminate tip; hence the hair has the appearance of a barbed spear. By its late appearance in development and its epidermal structure some do not regard the pappus as a calyx, while on the other hand others consider it so, though very much reduced in form and structure, the result of the pressure of surrounding bodies.

A little previous to the formation of the pistil another structure may be seen to arise from the receptacle between the individual florets. These foliar bodies, or bracteoles, very much resemble the scale-like leaves of poorly developed vegetative branches. They project quite far between the individual florets; their epidermal tissue consists of very thick-walled, elongated cells surrounding several layers of smaller parenchyma cells.

The next and last of the floral organs to appear is the pistil. About the time when the stamens begin to assume an oval outline and form a constriction near their bases, thereby separating the stamineal tissue into anther and filament, there is detected, on the inner border of the primitive ring in the region of stamineal insertion, an inward growth of cells. This cell tissue gradually develops inward around a common axis until all sides meet, and at the same time elongates in the direction of the flower axis, thus forming the style above and completely overarching the once oval cavity below, changing it to a flask-shaped cavity which is the true ovarian cell. Just at this stage of development it may be mentioned that from now on, the flower parts develop with remarkable rapidity, and finally the flower axis is very much elongated, the gynœcium forming the terminal structure of the flower. The growth of the pistil is somewhat analogous to that of the stamen. As before stated, stamineal growth is partially retarded up to a certain

point, from whence it makes rapid strides by the elongation of the cells of the filament; and for a time the stamen crowns the summit of the flower. So there is a similar phase of growth which characterizes the style: there is a slight cessation of its growth until the anthers begin to shed their pollen, when the style by rapid development pushes its way up through the syngenesious stamens. The lengthening of the style is due to the growth and elongation of the carpellary cells above the ovary. In this case is found a good example of proterandry, which indicates cross-pollination. After the opening of the flower the style lengthens and the pollen is pushed out of the anther tube by the brush-like upper portion of the style as the anthers dehisce. The lines of the stigmatic receptive surface remain intact until that portion of the two branched style is shoved above the anther tube, whence the two branches separate, curving far back and exposing the stigmatic papillæ on their inner faces; thus the style is made the instrument for disseminating the pollen which it cannot use for itself; as a result, cross-pollination, with almost absolute certainty, is insured.

To speak further of the two-branched style: Two kinds of hairs are detected, viz., stigmatic papillæ and brush hairs. The former are usually short, being either acutely or obtusely tipped, and are confined to the inner faces of the style branches, while the latter are cylindrical, epidermal outgrowths, having various arrangements both on the inner and outer faces of the style-branches. In Aster the style-branches are flattened and linear from their bases to the ends of the two lines of papillæ which line each stigmatic surface. Above the termination of the stigmatic lines are seen brush-hairs which cover both faces of the style-branch. In Solidago the style-branches resemble very much in outline those of Aster. Two stigmatic lines are observed which extend from the base of the branch to a point about one-half the distance to its tip. The brush hairs usually cover the whole outer surface of the branch, and the edges and tip of the inner face above the termination of the stigmatic lines.

It yet remains to speak of the tissue and its modifications that make up the structure of the style. It consists chiefly of ordinary parenchyma, the central portion of which is modified parenchyma, while the upper stigmatic portion is a differentiation of the epidermis into a soft mucilaginous tissue, thus forming a loose conducting mass for the penetration of the pollen tube. In the center of the conducting tissue is also seen a very narrow tubular opening, indicating that it is a continuation of the ovarian cavity. This seems to be constant throughout the species examined. Before concluding, however, the description of

the different floral organs, let the following order of succession as observed in their sequence of development be noted, viz.: corolla, calyx, andrœcium and gynœcium, although this order of parts does not correspond to Goebel's generalizations on Compositæ. There may be evidences showing a disturbance in the acropetal order of development of whorls, but of necessity the calyx is developed first, and its late appearance, without doubt, is due to the late setting free of its upper portion.

Simultaneously with the development of the ovule appear small, fleshy glands above the ovary at the base of the style; these form a disc, and are supposed to represent an inner row of imperfectly formed stamens.—GEORGE W. MARTIN (in 'The Development of Flower and Embryo-sac in Aster and Solidago").

ZOOLOGY.

On Nectonema agile Verrill.[1]—Ward, H. B.—Dr. Ward's paper upon this curious nematode has been awaited with considerable interest by all who heard his preliminary paper given before the Society of American Morphologists last winter, and, in justice to Dr. Ward and Prof. Mark, in whose laboratory the work was done, it must be said the paper is up to our expectations. Many curious thread-worms have been described heretofore, but helminthologists have generally been able to give homologies in other species for all the organs mentioned. Verrill's curious *Nectonema*, however, is a worm which possesses certain structures which are totally foreign to other nematodes.

According to Ward, *Nectonema* is a long (50–200 mm.), slender and exceedingly active round worm, found swimming at the surface of the sea with a rapid, undulatory motion. The anterior portion of the body is semi-transparent, and internally an anterior chamber is divided from the general body cavity by a partition which is concave anteriorly. This anterior chamber, together with its contents, is the most interesting part of the animal in question, for it is a structure which we cannot at present homologize with any organ of other nematodes. It is traversed by the rudimentary œsophagus, and contains ventrally the brain, while the dorsal space is occupied by four large conical cells which send processes down into the nervous matter of the brain. These cells are looked upon by Brüger as gland cells, but Ward supports the view that they are ganglion cells, which were situated on the surface of the brain, have become enormously large, and have extended up above the brain into the lumen of the anterior chamber. At first thought this supposition would seem rather far fetched, but, curiously enough, Ward has shown that there are in the brain five pairs of large ganglion cells which are quite constant in their position and which resemble these two pairs of dorsal cells in certain respects; *the fifth pair of cells is only half in the brain and half projecting above it, thus apparently forming the first stage in the migration which the dorsal cells have already accomplished.*

The digestive tract is quite rudimentary, and, as Ward states, points directly to the view that *Nectonema* is, in all probability, a parasite during the earlier part of its life.

[1] Bulletin Mus. Comp. Anat., Cambridge. 1892. Vol. xxiii, p. 135–188, with 8 plates.

In regard to the position of this worm in the classification, Ward believes that it is more closely allied to *Gordius* than to any other known nematode. The general structure, the ventral nerve cord, the anal ganglion, the absence of lateral lines, and the dorsal position of the sexual organs, together with the terminal openings of the same, all tend to support this view.

For other interesting details in regard to *Nectonema*, we must refer to the original article. At the same time we wish to call attention to the American *Gordiidæ* and Mermithidæ which would afford a most interesting and valuable field for scientific work. They should be worked up from the systematic, embryological and anatomical standpoints, and the reviewer thinks, judging from the admirable way in which Dr. Ward has studied this closely allied form *Nectonema*, that Ward is in an especially good position to revise these two families. Reviewer would hence take the liberty of suggesting the revision to Dr. Ward as a field for future investigation.—C. W. S.

Linton on Entozoa.[2]—Dr. Linton has recently published the results of his studies on the following parasites of birds:

1. *Filaria serrata* sp. n. is described from the intestine of *Circus cyaneus hudsonius.* The description is based upon a single male specimen, and is very incomplete. In the figures of the head two slings are drawn, which, if the drawing is correct, would probably place the species in the genus Dispharagus. But as Linton does not make any statements in regard to the œsophagus, the original material must be re-examined to determine this point.

2. *Ascaris spiculigera* R. was found in *Pelecanus erythrorhynchus.*

3. *Echinorhynchus rectus* sp. n. is described from *Larus sp.*

4. *E. striatus* Goeze was found in the intestine of *Oedemia americana.*

5. *Holostomum variabile* Nitzsch, found in several species of birds.

6. *Distomum (?) verrucosum* sp. n. Under this name the author describes a fluke found in the intestine of *Larus californicus.* As basis for the description, Linton had one entire specimen and a fragment of a second specimen. Unfortunately, he has made the mistake to start with, of choosing a specific name which has already been applied to three other species of the same genus (*D. verrucosum* Molin, from *Labrax lupus; D. verrucosum* Poirier, from *Thynnus vulgaris*, and *D. verrucosum* Busch, from *Ophidium barbatum*). Von Linstow gives these three in his Nachtrag (Compendium der Helminthologie,) as different species. I have not the articles at hand at present, so cannot state

[2] Notes on Avian Entozoa (Proc. U. S. Nat. Mus., Vol. xi, pp. 87–113, Pls. iv–vii.)

PLATE XXX.

Osteolaemus tetraspes. The African Alligator Crocodile.

whether any two of them are identical with each other or similar to Linton's species. At any rate, the name is clearly preoccupied, and it is inconceivable how Linton could give the same name to a fourth species which he describes as new.

7. *Distomum flexum* sp. n. from *Oedemia americana.*
8. *Dibothrium cordiceps* Leidy. *Larus californicus* as a new host.
9. *D. exile* sp. n., from *L. californicus.*

Epision gen. nov. Diagnosis: "Anterior end of body (head) lamellate, more or less crispate, deflected. Body proper, tæniæ form, segmented, segments not distinct. Reproductive apertures lateral (?)."

Epision is, without doubt, identical with *Tænia malleus* Goeze, 1782. Since Goeze's time, the parasite has been mentioned by Zeder, 1800; Frölich, 1802; Rudolphi, 1808, 1810, and 1819; Bremser, 1824; Creplin, 1839; Dujardin, 1845; Schlotthauber, 1860; Krabbe, 1869; Krefft, 1871. It has been figured by four of these authors.

10. *E. plicatus* sp. n., from *Oedemia americana.*
11. *Tænia* sp. fragments from *Larus* sp. and *Colymbus* sp.
12. *Tænia porosa* R. from *L. californicus.*
13. *T. filum* Goeze, from *L. californicus.*
14. *T. macrocantha* sp. n., from *Oe. americana.*
15. *T. compressa* sp. n., from *Fuligula vallisneria.*

It must be confessed that Linton's paper is a disappointment, and far inferior to his papers on the parasites of fish. Although he has given good descriptions of the external appearance of the parasites, measurements, etc., yet he has said almost nothing about the internal organs. In fact, he has described as a new species of *Dibothrium*, a form in which no genital organs were developed; while in his supposed new genus he cannot even give the position of the genital pores with certainty, and tells us practically nothing in regard to the genital glands. In the case of *T. filum*, *T. macrocantha* and *T. compressa*, an attempt is made to figure the genital organs, but the figures are very poor, too small and do not contain enough detail. We are told nothing of the number of testicles or of the topographical relations of the various organs.

The time has now passed when an helminthologist is justified in creating new species or new genera of tape-worms on external form alone, especially when only one or two specimens are at his disposal. If specimens of Linton's species were sent to me for determination, and I knew the hosts from which they came, I might be able to determine the various forms; but I must confess that if the parasites alone were sent, with no statement as to where they came from, it would be practically impossible to recognize the species. Even with the forms

with which I am best acquainted, i. e., with the parasites of man and the domestic animals, I rarely trust myself to diagnose a tape-worm without first examining the anatomy of the segment, for I have found that after examining no less than 1200 tape-worms of cattle and sheep, it is the easiest thing in the world to make mistakes such as diagnosing a *Moniezia planissima* as *M. expansa* or as some other species. The helminthologists all over the world have now recognized the uncertainty of external form, in determining Cestodes and Trematodes, and are revising the orders with reference to their anatomy; and with this movement in full force, I cannot understand how such an exact observer as Linton now allows himself to publish new species based on the external appearance of one or two specimens. It must, of course, be admitted that he could probably recognize the species again, since he has studied the type, but he should remember that his colleagues cannot obtain the same impressions from any description, no matter how good it may be, which he obtains from seeing and studying the original animals.

It is to be hoped that our friend, Dr. Linton, will obtain more material of the species he has described, and that he will favor us with exact accounts of their internal topographical anatomy.

—C. W. Stiles.

Systematic Arrangement of the Families of Birds.[3]—Prof. Max Fürbringer calls attention to Dr. L. Stejneger's systematic arrangement of the families of birds as adopted in the *Standard Natural History.* Although Fürbringer differs in his ideas from Stejneger, he expresses his "volle Bewunderung" at the latter's system, and continues, "Es ist die ernste That eines hervorragenden, in seiner Methodik auf den rechten Bahnen wandelnden Forschers and Denkers und verdient als solche den besten neueren Vogelsystemen gleich gestellt zu werden."

Shufeldt on the Anatomy of the Humming-Birds and Swifts.—In his review of my popular monograph of the humming-birds, in the October Naturalist, Dr. Shufeldt declares my description of the humming-bird's tongue to be erroneous, and "kindly invites" my attention "to the very careful dissections made by the Scotch anatomist, W. MacGillivray," and also his own "extensive dissections," the results of which were published in *Forest and Stream* for July 14, 1887, p. 581. The inference clearly is that Dr. Shufeldt would have me appear ignorant of both these treatises, though he should know that I am

[3] Journal für Ornithologie, April, 1892.

quite as familiar with them as he is himself. The facts of the case are that my purposely brief description, which Dr. Shufeldt criticizes so harshly and unnecessarily, is substantially a condensation of MacGillivray's—my knowledge of the subject being based chiefly on the latter and Mr. F. A. Lucas' later dissections of thirteen species[4] (instead of one, as in the case of Dr. Shufeldt's "extensive dissections").

Dr. Shufeldt's peculiar notion that the swifts are more nearly related to the swallows than to the humming-birds, first set forth by him in 1883, was so thoroughly "exploded" by his reviewers[5] that his resurrection of so dead an issue surprises me. Apparently he is not familiar with the literature of the subject, for, if he were posted, he would know that leading authorities on avian comparative anatomy are overwhelmingly if not unanimously against his side of the question. I would therefore suggest that he consult Fürbringer, Parker, Garrod and Gadow, and thus discover how much he has to learn regarding the matter which he handles with so much assurance. Even a careful perusal of Huxley (whom, by some strange hallucination, he imagines his abettor) may also prove instructive to him.—Robert Ridgway.

[4] Cf. Proceedings U. S. Nat. Mus. Vol. xiv., No. 848, pp. 169–172, pl. iv.

[5] Cf. Stejneger, *The Auk.*, July, 1886, pp- 404–406, and Lucas, *The Auk.*, October, 1886, pp. 444–451.

EMBRYOLOGY.[1]

Entwicklungsmechanisches.—Awaiting the publication in the Zeit. f. Wiss. Zool. of a fully illustrated account of his exceedingly important work upon the value of cells in cleaving eggs, Hans Driesch[2] puts forth a short preliminary notice of results recently obtained at Naples.

Having previously shown[3] that one of the first two cleavage cells in an echinoderm could, by itself, form a complete larva, the author now wishes to combat the view that any real process of regeneration here leads to the formation of the symmetrical whole animal from the half ovum. This idea of a regenerative process has just been maintained by Chun in a paper presented to the *Deutsche Zool. Gesellschaft*, and very briefly noticed in the *Zool. Anz.*, xv, June, 1892, p. 225. Chun separated the first two cleavage cells of the Ctenophore *Bolina*, and found each could produce a half-animal that later became a complete one by regeneration. This process was seen also in many eggs not artificially interfered with.

Hans Driesch removes one of the first four cleavage cells of a sea-urchin and finds the remaining three cleave as if the fourth were still present, yet later a normal, but smaller, blastula (and in more than twenty cases a normal pluteus) is formed. One of the four cells may also, in some cases, give rise to a normal but very small pluteus.

Thus we may take almost any fraction of the cleavage material and, if it is not *too* small, obtain an animal differing from the normal only in size.

The author maintains that there is no re-formation of the removed cleavage material, but the amount present closes in to form a small blastula. There is no regeneration.

In these facts is also seen the fundamental identity of the cleavage cells, their lack of preordination. To emphasize this conception of the value of cleavage cells the author communicates the results of experiments the details of which we hope will soon be made known in his complete demonstration. In the egg of the sea-urchin the first three spindles lie in an equatorial plane, then the next four in a verti-

[1]This department is edited by Dr. E. A. Andrews, Baltimore, Md.

[2]Anatomischer Anzeiger, vii, Aug., 1892.

[3]See AMERICAN NATURALIST, Feb., 1892, p. 178.

cal plane (whence the eight cells, four above and four below, result). Now by the application of pressure it is possible to force all these spindles to lie in one plane, whence there results a plate or single layer of eight cells. These cells may remain in this abnormal position and divide vertically so that there are two layers of eight or in all sixteen cells, which subsequently divide tangentially. A little consideration will convince one that here cells, or nuclei, normally forming part of only one pole, give rise to parts of both poles. Since these confused cleavage cells may proceed to form normal plutei their indifferent, omnipotent character cannot be disputed.

These and other experiments, not here revealed, lead Hans Driesch to the following conceptions of the value of cleavage: (1) Cleavage forms a homogenous, indifferent material any portion of which, almost, may form a complete organism when isolated or any part of an organism when united with other portions. (2) The embryo acquires form through unknown laws of correlation; it is not a mosaic as Roux has maintained.

Budding in Hydroids.[4]—Contrary to the usually received conception, Mr. Albert Lang, working with Prof. Weismann, contends that in hydroids buds are formed not by equal outgrowth of both ectoderm and entoderm, but primarily by the growth of the ectoderm alone, this germ layer early giving rise to a new entoderm for the bud.

In an introductory note Prof. Weismann relates that purely theoretical reasons, the probability that "bud idioplasm" is confined to certain cells of the ectoderm, led him to doubt the participation of the entoderm in the formation of hydroid buds.

The body of the paper is devoted to a description of sections made through *very early* stages in the budding of *Eudendrium racemosum*, *E. ramosum*, *Plumularia echinulata*, and *Hydra grisea*, preserved for the most part with the aid of corrosive sublimate.

Although in the stages usually examined the ectoderm and entoderm of the bud are continuous with those layers in the adult and surround a prolongation of the gastric cavity of the adult, yet the study of very early stages shows that this continuity does not arise by mere proliferation in each layer. At first there is a thickening of the ectoderm over the area that is to give rise to the bud; here the basement membrane appears to be dissolved; is at all events absent; thus ectoderm and entoderm are here continuous with one another; rapid cell division takes place in the ectoderm, while the entoderm seems to remain

[4]Zeit. f. Wiss. Zool., 54, July, 1892, pp. 365–383.

passive, or after a time is even cast off or degenerates; certain small ectoderm cells *appear* to migrate into the entoderm and are interpreted by Mr. Lang as there giving rise to a new entoderm. While a new basement membrane is soon formed over most of the budding area it remains indistinct or absent around the periphery; a solid outgrowth is thus formed, within which a cavity appears by the separation or rearrangement of the new entoderm and loss of the old; we thus arrive at the two-layered, hollow outgrowth commonly regarded as the earliest stage in the formation of the bud.

Unfortunately the illustrations given by the author are not numerous enough to convey to the reader the same convictions that the study of series of sections might. The equally important and difficult questions, the migration of ectoderm cells and their conversion into new entoderm seem to require a reinvestigation of the subject before we can be fully convinced that the ectoderm is really the only seat of proliferation in budding hydroids.

Comparing this bud formation with embryonic processes, the author points out the close parallelism between the formation of new entoderm by multipolar migration from the ectoderm of the bud and the formation of the entoderm of the embryo by migration of ectoderm cells of the blastula.

Instead of regarding the process of budding in coelenterates as a modified fission of the adult we may refer it back to the blastula stage and explain it as acquired in some ancestral blastula form, as an atavistic representation of a non-sexual mode of reproduction in a blastula-like coelenterate ancestor.

Similarly Seeliger has interpreted budding in Bryozoa as due to a process of twin-formation in the embryo.

Budding in annelids, tape-worms and scyphistomas, where all germ layers are concerned, may still be regarded as having arisen from regenerative processes. Budding in Salpa remains unexplained.

Notes on Elasmobranch Development.[5]—Prof. Adam Sedgwick brings forward some new facts and considerations tending to support his theory of the origin of metamerism in animals and also making clearer his views upon many important questions illustrated by his observations upon the embryos of Scyllium and Raia.

The blastopore of elasmobranchs, immediately before it closes, is an elongated, narrow slit, slightly dilated in front, where it lies on the floor of the medullary canal, and more dilated behind (Balfour's yolk-

[5]Quart. Jour. Mic. Sci., June, 1892.

blastopore). Between these two limits it takes the course of a reversed letter S. The anterior part perforates the medullary canal and is dorsal; this is continuous round the end of the tail with a ventral part, which extends forward along the ventral side of the tail as far as the yolk-stalk. Along this it passes to continue backward along the yolk as the slit-like, non-embryonic part of the blastopore, which passes behind into the more dilated and posterior part of the so-called yolk-blastopore. In the author's view the blastoderm grows uniformly over the yolk at all points of its circumference. The notch of the embryonic rim represents the anterior end of the blastopore and the blastopore does at one time or another perforate the whole length of the medullary plate; anteriorly it keeps closing up as the embryonic rim grows backwards, so that it is never present in this region as more than a notch. Yet there is no "concrescence"—"to talk about concrescence and fusion of two halves is merely obscuring the real question and seeking to explain a process of growth by a phrase which has no satisfactory meaning."

The anus is formed within the area of the blastopore; is actually a part of the blastopore in some vertebrates; not so the mouth.

In *Scyllium canicula* the mouth is at first a longitudinal row of dots between the mandibular arches. These pores become connected to form a longitudinal slit extending forward into the rudiment of the pituitary body. Later the mouth shortens and widens to the adult form. Its slit-like form may be favorable to the view that it is derived from the anterior part of the blastopore, "though I admit that this does not constitute a very powerful argument."

The mandibular, hyoid and branchial arches are very much bent backward, which suggests that there has been not only a cranial but a cephalic flexure affecting brain, notochord and arches as well. Before such a flexure the mouth was a vertical slit looking forward or even extending onto the dorsal surface.

Regarding the metamerism of the head the author thinks that the number of primitive somites in any region of the head differs in closely allied genera. Hence the adult segmentation, constant throughout the vertebrates, has little value in determining the primitive metamerism. "We may, I think, even go farther and say that the adult arrangement of nerves and branchial arches, etc., characteristic of the vertebrate head, must have arisen subsequently to the disappearance of the primitive segmentation." The first or premandibular somite of Balfour, arising from a mass at first connected with the ectoderm, with the notochord and with the anterior end of the gut, thus presents

some resemblance to the primitive streak of the Amniota, and appears to contribute as a growing point to the anterior end much as the primitive streak does to the posterior end of the embryo.

Turning now to quite a different subject, the author affirms that in all the vertebrate embryos he has examined there is a protoplasmic continuity between the different layers and organs. "The cells of the young embryo, subsequent to cleavage, are connected by delicate processes. There can be no reasonable doubt that it (the network of such processes) is derived from the processes and strands left between the cells as a result of the incomplete cleavage of the ovum." Awaiting an investigation of this subject, which the author hopes to treat of in a future paper, he yet thinks "that there is, in my opinion, evidence to show that the whole of the nervous connections (by nerve-fibres and otherwise), both in the central organ and at the periphery, are developments of this pre-existing network, which connects together at all times the whole of the cells derived from the fertilized ovum."

Embryology of a Nematode.—A welcome addition to the scant literature of this subject has been made by Benno Wandolleck.[6] He studied fresh and preserved material of *Strongylus paradoxus*, devising some new and interesting methods.

Peculiar changes in the arrangement of yolk-spherules precede cleavage; the first plane is meridional and the cell at the animal pole, where the polar bodies were formed, has no coarse yolk, while the cell at the other end of the elongated egg is completely full of it. The clear cell gives rise to all the ectoderm, and at first is where the anterior end of the animal will be; the granular cell gives rise to the entoderm and the mesoderm, and is at first where the tail of the animal will be. The two cells rearrange themselves so that the ectoblast cell lies partly dorsal and the mes-entoblast cell partly ventral.

Subsequent divisions result in a solid mass of cells in which the more numerous, smaller ectoblast elements form a dorsal cap over the few granular, larger mes-entoblast cells. As an epibolic gastrula begins to form, a pair of mes-entoblasts become recognizable as the primary mesoblasts, whence arise two simple rows of mesoblast cells, one on each side. These two longitudinal mesoblast rows run parallel with the edges of the blastopore slit formed by the overgrowing ectoblast. This blastopore closes completely the anterior part last; at that point the mouth subsequently forms by a new invagination. The entoblast is now only two rows of few, large cells; these subsequently

[6] Archiv. f. Naturg, 58, 1892, pp. 123–147, plate IX.

separate from one another, after their number is increased, to leave the lumen of the digestive tract. Only short stomodeal and anal invaginations arise from the ectoblast.

As the mouth forms, ectoblastic cells around it sink in to form the nervous system. The reproductive organs are recognizable before this, as two large cells, one in each of the rows of only five or six mesoblast cells.

In the main the paper confirms the observations of Gotte upon Rhabditis.

Note on an Abnormal Polygordius Larva.—Since reading Mr. E. A. Andrews' article on Bifurcated Annelids in the September number of this journal, it has seemed to me that some notes and sketches which I made during the summer of 1890 while enjoying the privileges of Mr. Agassiz's laboratory at Newport, R. I., are of sufficient interest to warrant their being published. They relate to a case of a peculiar bud formation in Polygordius. The larvæ of this annelid were very abundant for several weeks both before and after the dates here mentioned, and after this abnormal individual was observed all the tow that was brought into the laboratory was carefully examined for similar specimens, but none were found.

Figure 1 represents the larva as it appeared when first seen on August 9. The body was about equal in length to the longest axis of the head. So far as could be seen the head differed in no respect from that of the normal larva.

The bud was situated on the dorsal side of the body close behind the head, and was about equal to the body in both length and diameter, though as shown by the figures it was quite markedly club-shaped, the larger end being distally directed. The outer layer of the bud was distinctly continuous with the corresponding layer of the body, though neither at this nor at any later stage did it show anything of the superficial ring-structure or of the pigment spots, such as were seen in the body. I could not make out precisely the relation of the digestive tract to the bud, though its wall seemed to be folded somewhat in this region, the fold being capable of being thrust into the bud for a short distance.

A mass or thick strand of tissue could be seen within the bud, extending from near its base out to its tip, there to become fused to the inner surface of the distal wall of the bud. This strand was clearly separated all around from the external wall of the bud by an empty

space of considerable size, but I could not make out that the strand itself contained a lumen.

Neither at this nor at any later time did the digestion tube extend into the body behind the bud excepting as a mere diverticulum, though there seemed to be a body cavity in this region—more distinctly seen, however, at later stages.

A ciliated band was not present at this time, either at the posterior end of the body or at the tip of the bud, though in each place a circle of pigment spots was to be seen.

On the morning of August 11, forty-eight hours after the first sketch, shown in Figure 1, was made, the one shown in Figure 2 was drawn.

Both body and bud had increased in length considerably, but the former more, proportionally, than the latter. The digestive tube could now be distinctly seen to extend for a considerable distance into the bud, though it was constantly being thrust in for a greater or less distance and again withdrawn. There was a sort of fold just at the entrance that was continually changing its shape and position, by reason of which it was impossible to determine exactly what was the relation of the intestinal wall to the body wall.

The strand of tissue in the bud mentioned as being present in the preceding stage, has practically the same appearance and relations now, excepting that it was proportionally shorter.

The body cavity behind the bud was now quite distinct, and there was a circle of cilia around the body near its posterior end, but none on the bud. At this time the bud could be seen to contract somewhat.

While this sketch was being made the cilia of both the head and the posterior end of the body, together with some of the pigment spots of the head band were suddenly thrown off, and the animal sank to the bottom of the dish and became quiet, whereas it had before this time been swimming rapidly about.

Twenty-four hours later the sketch was made which is represented in Figure 3. The head was now much reduced in size, and the body correspondingly increased in length. The bud had also increased in length somewhat, but much less proportionally than the body.

The most interesting new feature observed at this time was that there was a communication between the digestive tube and the outside world through the bud, the anal opening being situated at the tip of the latter. Conclusive proof of this was furnished by the fact that a mass of fecal matter was seen to pass from the intestine into the bud and then out into the surrounding water. But still I could not be sure as to the real relation of the digestive tube to the external layer

of the bud. The fold mentioned in the preceding stage (*a* in Figure 3) was very distinct here, but was not usually in the position shown in the figure, i. e., projecting into the digestive tube, but was most of the

FIG. 1.

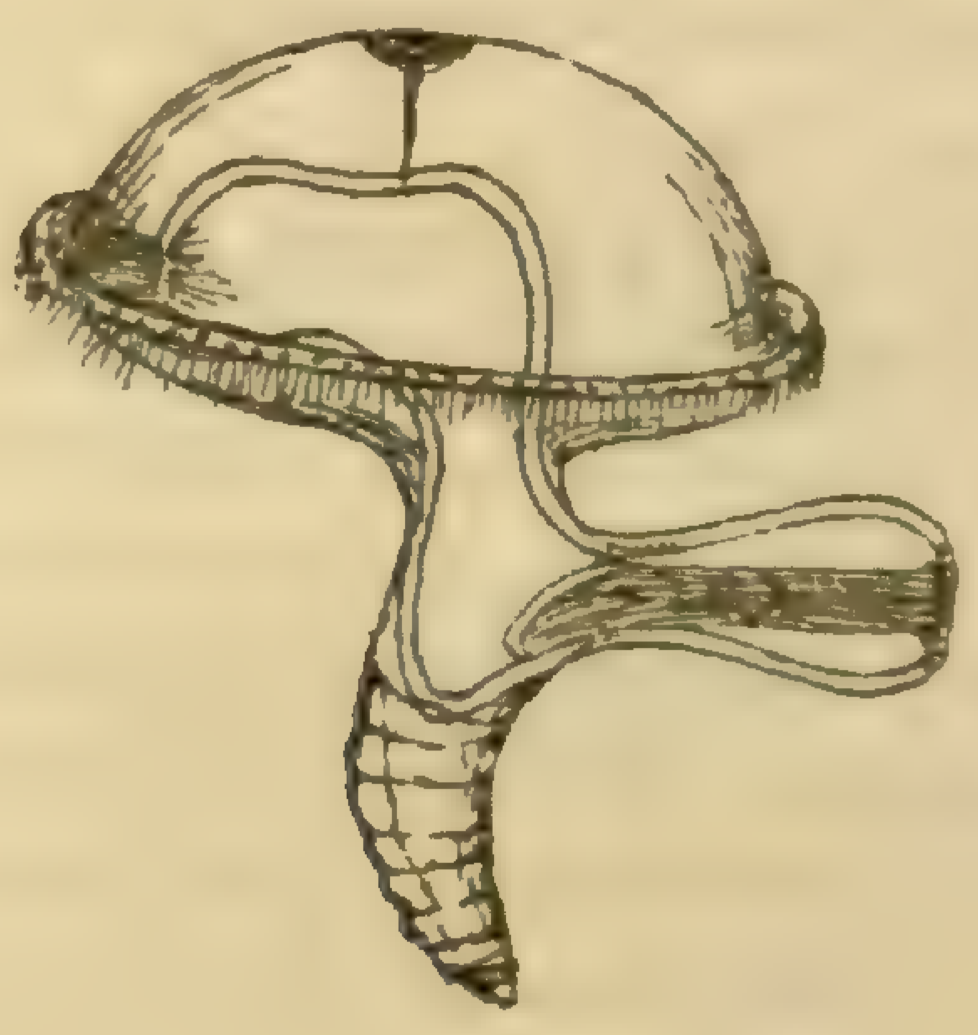


FIG. 2.

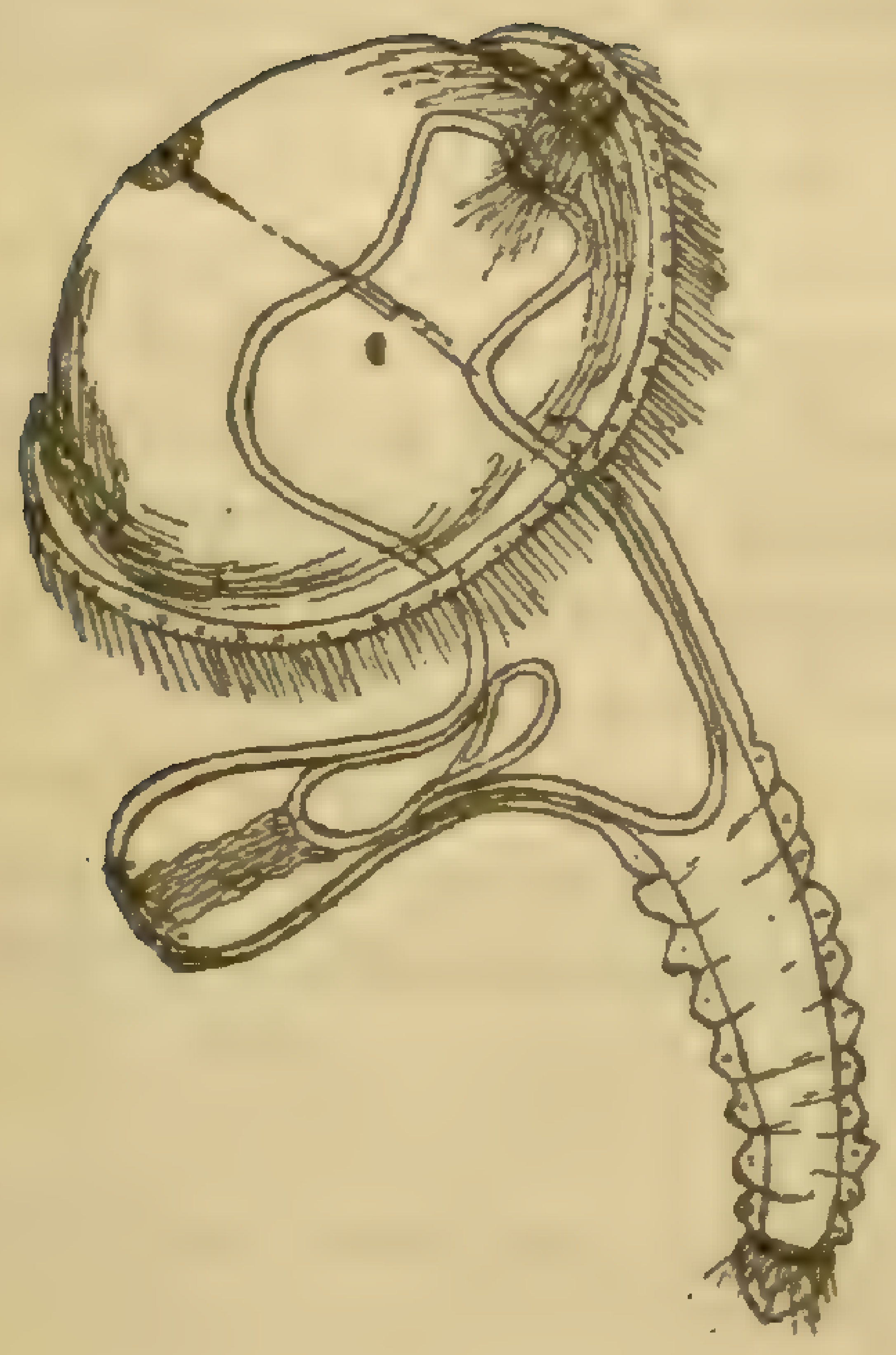
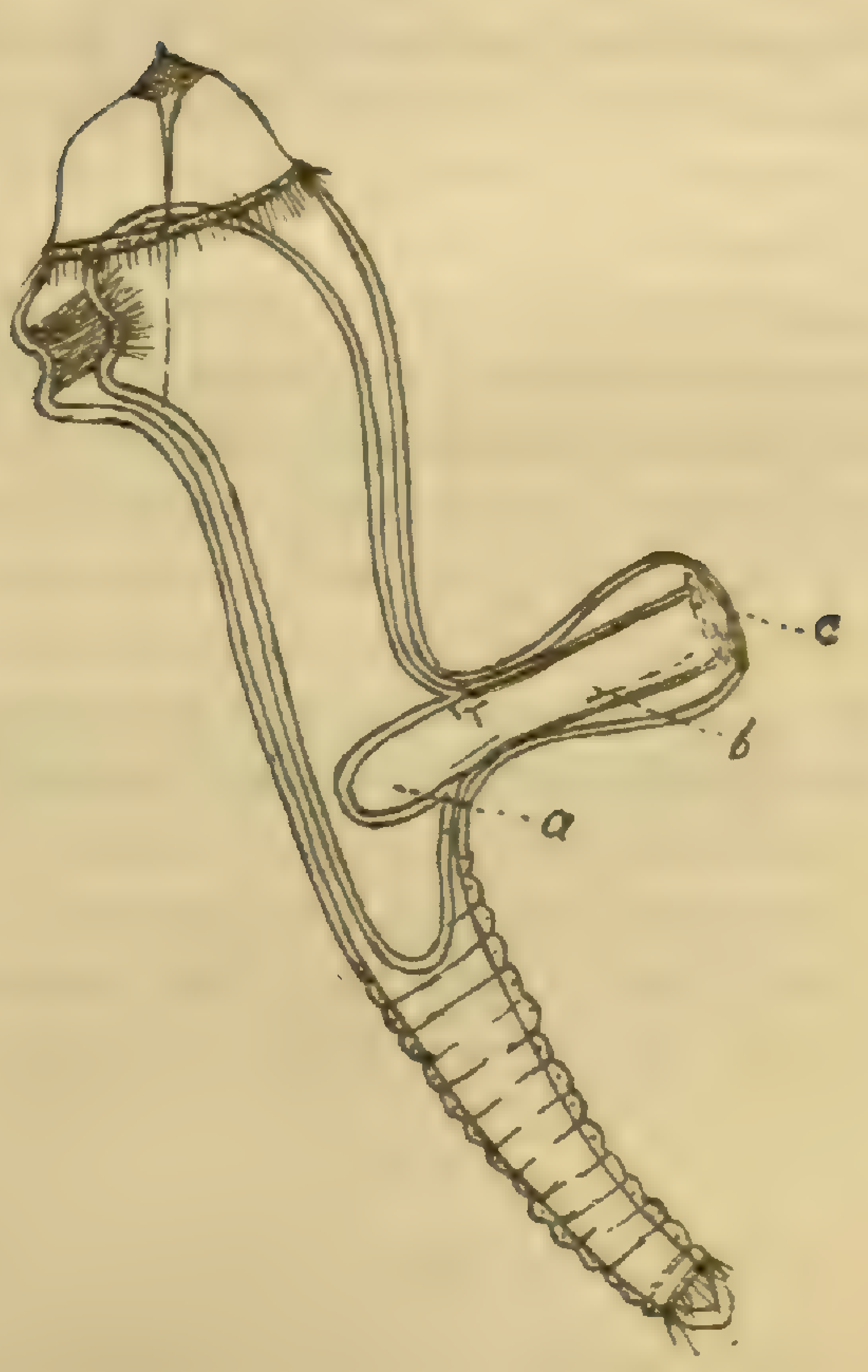


FIG. 3.



time thrust far into the bud, and it is certain that the fecal matter just spoken of passed *through* this. It is my belief from all that I could make out, that the strand of tissue described in the former stages now

contained a wide lumen throughout its length, and that into this the diverticulum of the intestine, with an anal opening at its distal end, was alternately thrust and withdrawn. The fecal mass did not seem to be *carried into* this lumen by one of the eversions of the intestine, as we might now call the portion of the digestive tube that extended into the bud, but to pass directly into the cavity, *b*, and from there to the outside world by the anus at *c*.

Although the fold, *a*, changed its form and position frequently, as already explained, the movements were never seen to affect the portion of the wall of the digestive tube immediately at the entrance of the bud. From this fact and the obvious close relation of the two layers in this region, I conclude that there was an actual connection between them here. At this time both the preoral and anal bands of cilia were present, and the larva was swimming about actively. On the following morning, however, it was dead and so far decomposed as to be of no value as a preserved specimen.

Meaningless, and indeed impossible, as such a comparison would be in detail, one can hardly fail to be reminded by these figures of the young Phoronis at such a stage of its metamorphosis as is figured, for example, by Metschnikoff and copied in Lang's *Lehrbuch der Vergleichanden Anatomie.* Of course, should such a comparison be attempted, the main, or primary body of the Polygordius larva would have to be compared to the new, or secondary body of the Phoronis. Nevertheless, it is worth noticing that we have in this monstrosity, as in Phoronis, a contrivance by which the anus is transferred from the end of the body remote from the head to a position much nearer to it, this being brought about by a dorsal flexure upon itself of the digestive tract, the change being then essentially that required by Wilson's[1] speculation concerning the significance of the eversion of the digestive tract during the metamorphosis of Phoronis.—Wm. E. Ritter, University of California, Sept. 27, 1892.

[1]E. B. Wilson. The Origin and Significance of the Metamorphosis of Actinotrocha. Quart. Jour. of Micro. Sci., Vol. xxi, pp. 202–218.

PHYSIOLOGY.

The Functions of the Nervous System of the Myriapoda.—The following experiments on the nervous system of the Myriapoda were begun with the intention of continuing them upon some of the other Invertebrates, for the purpose of comparing the different relations. It has been impossible thus far to fulfil this plan, and therefore these results are given rather as preliminary than as complete in themselves.

The animal used in the experiments was the common species (*Lithobius*), and it proved a rather unfavorable subject. But the large *Iulidœ*, which would doubtless have been better, could not be obtained. The Lithobius is very active and quick in its motions, so that it was necessary to perform some of the operations while the animal was under the influence of chloroform. After the operation in most cases, some time, varying from an hour or two, to a day, according to the nature of the experiment, was allowed to pass before observations were made, this allowing recovery from the shock and from the irritation of the wound.

The method of experiment was as follows: a portion of the nervous system was removed or isolated from the rest, or destroyed by a cut or by burning with a loop of very fine platinum wire heated red-hot in an electric circuit. After recovery from the immediate effects of the operation the actions of the animal were observed at intervals until its death. The same operations were again and again repeated, so that the results given represent the observations of a large number of individual cases.

The superœsophageal ganglion consists essentially of a small whitish mass just beneath the dorsal surface of the anterior segment, sending out two lobes transversely, which end in the nerves leading to the eyes, and just beneath these two other lobes extending forward, and giving off the nerves which pass into the antennæ. This ganglion is connected with the ventral cord by two rather thick commissures, which form a very small œsophageal ring. The ventral cord is practically the same in structure throughout its whole length, being a double cord connecting a series of ganglia corresponding to the segments of the body.

The operations upon the superœsophageal ganglion were performed either by removing the head or some part of the ganglion by a cut, or

destroying it by means of the hot platinum wire. These operations give the following results. First, as is well known, the headless trunk shows no volition nor intelligence. If left without external stimulation it will remain quiet, until it dies, just as will the brainless frog. Yet, under stimulation, movements are made which are well coordinated, though not as perfectly so as when the ganglion is present. The trunk will start forward when touched, and will often advance its own length or more before becoming quiet again. But the motion becomes slower and slower until it ceases or until an obstacle is met, and the body is quiet until again stimulated. Some other protective motions may also be shown. The trunk will back away from a sudden stimulation in front, or the portion of the body touched may be suddenly jerked away, as in the normal animal. Further, if turned upon its back it quickly rights itself. All these actions, however, are weaker than when the superœsophageal ganglion is present, and are not performed with so much precision. The coordination of the motion of the legs is less exact, consequently the advance of the trunk is much slower, and sometimes when it is overturned several attempts are made before it succeeds in righting itself.

Another fact which is noticeable in regard to the superœsophageal ganglion, when a part of the ganglion is destroyed by the hot wire, is that the amount of influence exerted by the ganglion appears to depend on the amount of it which is left intact. A slight burn destroying only a small portion will leave the animal only a very little less active than the normal, while if the larger portion of the ganglion be burned out it is hard to distinguish the subject as regards its actions from the headless trunk. Between these two extremes there are all degrees of difference, so that it appears impossible to set any definite limit between the reflexes of the headless subject and the animal with the greater part of the superœsophageal ganglion destroyed. Moreover, the probable occasional presence of internal stimulation from the wound complicates the matter still further. Where a portion of the ganglion remains the motions continue a somewhat longer time than in the decapitated subject, and often before perfect quiet ensues, isolated motions of different legs occur at longer and longer intervals. In fact, in the two cases there seems to be an analogy to a delicate machine. In the first case, the decapitated trunk, the machine is set in motion by the stimulation but after a time comes to rest. In the second case the adjustment is more perfect and a longer time ensues before motion ceases. The delicacy of adjustment increases with the

amount of the ganglion present, until motion may be caused by stimuli so slight or of such a nature that they are not apparent.

The objection to which all experiments of this nature are more or less open may be raised here: viz, that the mutilation which is unavoidable in the operation would cause weakness and perhaps an apparent loss of function, even if no absolutely essential portions of the nervous system were removed. However, where the superœsophageal ganglion is not involved, the animal endures mutilation to such an extent without losing its volition and activity that the influence of the ganglion must be real and not apparent. Moreover, there is another fact which proves that the ganglion exercises a real influence. This fact is the presence of the so-called "forced motions" after an asymmetrical operation upon the ganglion. In all such cases the animal turns toward the uninjured side as it crawls, and thus goes about in a circle. This circular forced motion can be induced by a burn upon one side of the ganglion, and also by removal of one-half of the head with a pair of fine, sharp scissors. The animal recovers from the latter operation, and sometimes lives for twenty-four hours. The degree in which the forced motion is evident varies considerably. In some cases the diameter of the circle in which the animal moves is not more than an inch, while in other cases it is six or eight inches. The tendency to move in a circle appears to increase in strength as the animal becomes weaker, until sometimes, when nearly dead, it lies upon one side and turns within its own length. Two cases were observed in which the animal turned toward the injured side. In both these the operation was a burn on one side of the superœsophageal ganglion. Owing to accident the observations in both cases were not continued beyond the first so that the later phenomena are not known, but it seems probable that these forced motions resulted from irritation in the wound. A number of attempts were made in large specimens to cut one of the œsophageal commissures, but, owing to the extremely small œsophageal opening, and the small size of the animal, they were not successful. Steiner in a short article published a year or two since (Die Funktionen des Centralnervensystems der wirbellosen Thiere), states that with his large *Iulidae* he was able to cut a single commissure, and obtained very evident circular forced motion toward the uninjured side.

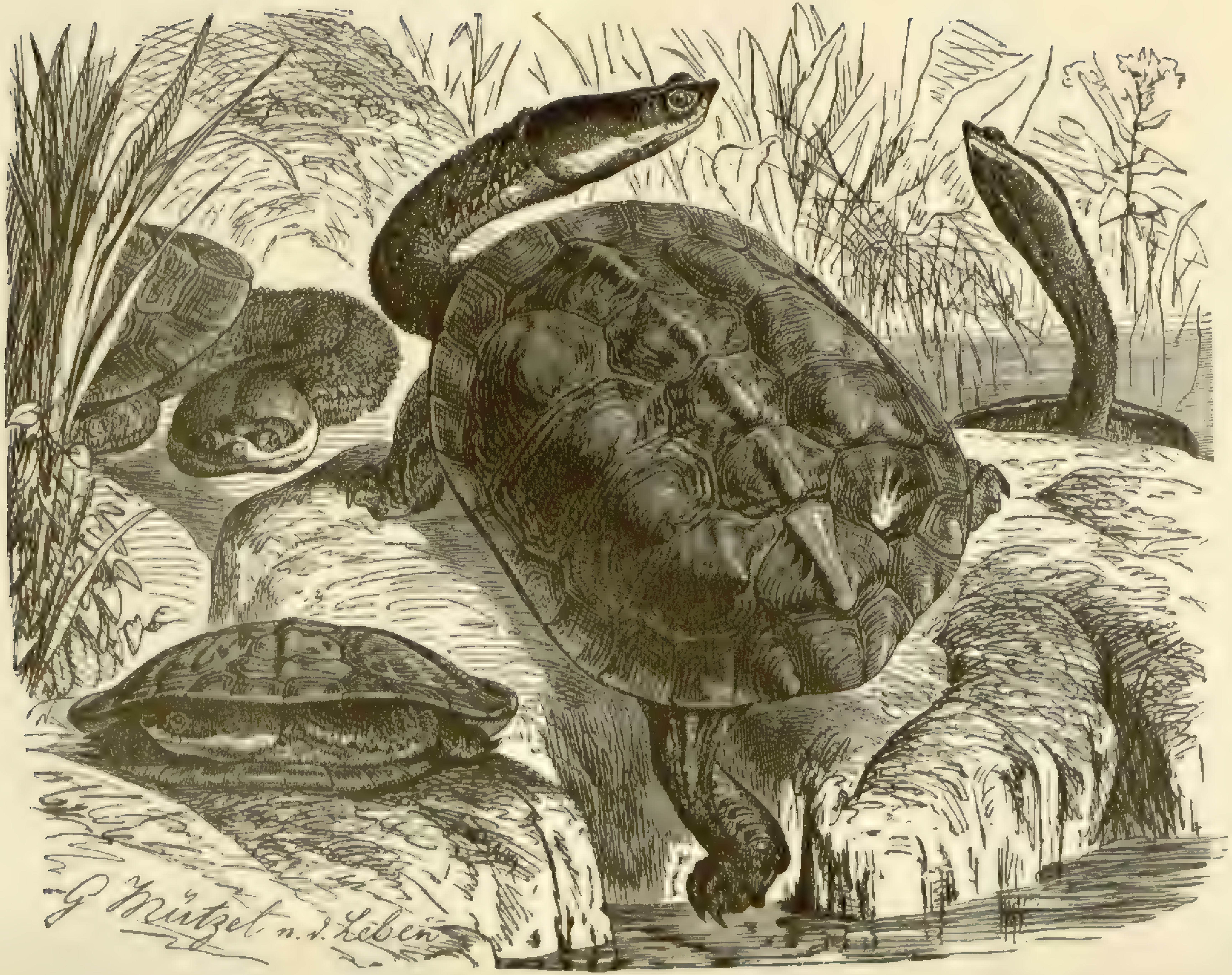
The superœsophageal ganglion, then, is a motor center to which all the motor centers lying in the ventral cord are subordinated. It enables them to respond to sensory stimuli with greater exactness and strength than would otherwise be possible. Besides this it is evidently

the center of the sense of sight and the sense of touch in the antennæ, and, moreover is the seat of whatever intelligence the animal possesses. The direction of the forced motion toward the uninjured side indicates that the fibers from the ganglion cross to the opposite side in their course. This crossing must take place in the extreme anterior portion of the ventral cord.

A part of the functions of the ventral cord are shown in the decapitated trunk. As stated above the power of coordination of motions remains to a large extent, and the animal is able to right itself when overturned. The decapitated trunk is, moreover, very sensitive to various external stimuli. A light breath of air will often set it in motion, and if the hot wire be held within one eighth of an inch the heat is usually sufficient to cause quite violent movements. This extreme sensitiveness to heat is very marked in all cases.

If now the different portions of the cord be examined, it appears that it is practically the same in function along its whole length. If a decapitated trunk be cut in half, both portions show about the same degree of activity, and neither varies much from the whole trunk except that in these smaller portions death ensues more quickly. Either of the two halves when overturned makes very evident attempts to right itself, but usually does not succeed because it is too short. If each of these halves be again cut in half, each of these pieces can still be made to advance by means of stimulation. When placed on the back some slight movements are seen which soon cease, and the piece remains perfectly quiet until again stimulated. Further than this the sense of equilibrium cannot be traced. It requires the presence of several segments in order to manifest itself. Whether, if the weakening effects of the shock and the extreme mutilation could be avoided, it would assert itself with the presence of a single ganglion cannot be definitely stated. It is, however, more probable that the coordination of more than one is necessary. The power of advancing when stimulated is still evident in a piece which possesses only three pairs of legs; a piece with two pairs of legs when stimulated makes movements, but apparently has not sufficient strength to advance. Portions of the trunk from the anterior and posterior part of the body appear about alike in these respects. Various other methods were employed in the examination of the cord, such as cutting or burning through the cord without severing the body, or destroying the superœsophageal ganglion without removing the head. They all lead to the same conclusions in regard to its functions.

PLATE XXXI.



Hydromedusa tectifera. The snaked-necked turtle.

The nervous system of the earwig, then, consists of, first, a series of centers which are capable, unaided, of responding to sensory stimulation by appropriate coordinated motions, in other words, a series of complex reflex centers lying in the ventral cord; and second, of a single ganglion situated in the head to which all the reflex centers are subordinated, and which contains also the centers for the eye and the antennæ, and the seat of whatever intelligence may be present. Steiner (Die Funktionen des Centralnervensystems und ihre Phylogenese; Zweite Abtheilung: Die Fische) regards a true brain as defined by the presence of a general motor center together with the centers of at least one of the higher senses. The superœsophageal ganglion according to this definition is a brain, and indeed Steiner so regards it. The ventral cord is analogous in function to the spinal cord of some of the lower vertebrates, being a series of coordinated reflex centers, with perhaps some automatic functions also, all of which are subordinated to the brain.

Some experiments of a similar nature were performed upon the Decapoda, but were not continued far enough to give any definite results except that, as would be expected, the superœsophageal ganglion is a brain, and that of the ventral portion of the nervous system the thoracic ganglion is the highest and most complex in function.

A few experiments upon the horse shoe crab (*Limulus polyphemus*) revealed the fact that the presence of the chain of small ganglia running backward, or even of part of it, even when entirely separated from the rest of the nervous system was sufficient to cause regular normal motion of the gills, which continued in some cases for two days, if the animals were left undisturbed in water. The motion usually ceases when the gills are exposed to the air or when they are suddenly stimulated but in a few moments the motion begins again if they are again covered with water.

The results here given are not all new, but it is hoped that the statement concerning the more simple functions of the nervous system of the Lithobius may serve as a basis for further work, and for comparison with the results obtained from other Invertebrates.

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PROCEEDINGS OF SCIENTIFIC SOCIETIES.

National Academy of Sciences.—This body met at the Johns Hopkins University, Baltimore, Nov. 1, 2, and 3. The following papers were read: *The Evolution of the Moon, G. K. Gilbert; *On the Observations for Latitude at Rockville, Md., T. C. Mendenhall; *On the Latitude Observations at Honolulu, T. C. Mendenhall; *Crystallized Vegetable Proteids, Thomas B. Osborne, introduced by S. W. Johnson; *A Spectroscopic Analysis of the Rare Earths, H. A. Rowland; †A Table of Standard Wave-lengths, H. A. Rowland; On the Motion of a Sphere in a Viscous Fluid, H. A. Rowland; †Volcanic Rocks of South Mountain in Pennsylvania and Maryland, G. H. Williams, introduced by Ira Remsen; On Some Curious Double Halides, Ira Remsen; †Study of the Action of Light on Acids in Solutions Containing a Salt of Uranium, Ira Remsen; *On Isothermals and Isometrics of Viscosity, C. Barus; Significance of the Follicle of Salpa, W. K. Brooks; †Biological Relations of the Oldest Fossils, W. K. Brooks; On the Vertebrate Fauna of the Blanco Epoch, E. D. Cope; On the Motion of the Earth's Pole, S. C. Chandler; The Use of Planes and Knife-edges in Pendulums, T. C. Mendenhall; Recent Improvements in Astronomical Telescopes, C. S. Hastings; Exhibition of Photographs Illustrating New Methods and Results in Solar Physics, George E. Hale, introduced by C. S. Hastings; Some Effects of Magnetism on Chemical Action, George A. Squier and Frank A. Woff, Jr., introduced by H. A. Rowland.‡

The President announced the deaths of members of the Academy since the last meeting as follows; Lewis A. Rutherford, of New York, died May 30, 1892, and Prof. W. P. Trowbridge died August 12, 1892. Prof. B. A. Gould, of Cambridge, was appointed to write a biographical memoir of Mr. Rutherford, and Gen. C. B. Comstock, U. S. A., to prepare the memoir of Prof. Trowbridge. The deaths of two foreign associates, C. H. C. Burmeister and A. W. Hofmann, were also announced.

The following are abstracts of three of the papers read:

In Mr. G. K. Gilbert's paper on The Evolution of the Moon, he said in part: "The surface of the moon, like that of the earth, is diversified by plains, uplands and mountains, and these various features have special characters in which they differ from those of the

* Read on November 1.

† Read on November 2.

‡ The remaining papers were read on November 3.

earth. The plains lie lower than other portions of the surface, and are distinguished by their darker color. By those who have mapped the surface of the moon they are called seas, but the word is used in a figurative sense, for it is well understood that there is no water on the moon. The mountains are usually in the form of rings, each ring inclosing a hollow, and to this form the name crater is given. They are scattered over the surface of the plains, and on the uplands they are thickly set, overlapping one another in every variety of relation. They are of all sizes, from the smallest that the telescope can discern to a diameter of several hundred miles. Those of medium and larger size are usually characterized by a smooth circular plain in the interior and a hill or group of hills rising in the center of the plain. They differ from the craters of the earth in various ways, especially in the fact that their bottoms are below the level of the surrounding country, and in the fact that the central hill bears no crater on its summit.

"The origin of these craters has been the subject of many theories. Despite their marked peculiarities of form, they have more commonly been ascribed to volcanic action; but they have also been referred to the bursting of gigantic bubbles, to the evaporation of water and its accumulation about the point of evaporation as ice, and to the impact of bodies from without. Personally, I favor the last mentioned explanation, but I differ from other writers in respect to the origin of the colliding bodies. It has been previously surmised that these might be rocks hurled from terrestrial volcanoes; that they might be meteors from the recesses of space, such as are continually burned in the upper layers of our atmosphere, giving rise to shooting stars, and that they might be aggregates of such meteors constituting balls of cosmic dust. Now my idea of their origin is based upon the phenomena of the planet Saturn and its ring. About that planet is a disc-like ring which astronomers believe to be constituted of an indefinitely large number of very small bodies revolving about the planet in parallel orbits—a symmetrically shaped form of small satellites. Assume that a similar ring of minute satellites once encircled the earth, and that these gradually became aggregated into a smaller number of larger satellites, and eventually into a single satellite—the moon. The craters mark the spots where the last of the small bodies collided with the surface when they finally lost their independence and joined the larger body.

In Prof. G. H. Williams' paper on The Volcanic Rocks of South Mountain in Pennsylvania and Maryland, he announced that during the past summer he had been able to clearly identify over 175 square

miles of rocks exposed along the eastern side of South Mountain as ancient lavas. "These rocks," he continued, "have been heretofore often described by geologists, but have been considered to be of sedimentary origin. To any one, however, familiar with the products of recent volcanic regions the proofs of their lava character are convincing. In spite of their great age and complete recrystallization they still retain the minutest details of their original structures. Even under the microscope they are hardly to be distinguished from recent glassy or half-glassy rocks from the Yellowstone Park or from southern Italy. In chemical composition also they show surprisingly little change.

These old volcanic rocks present two sharply contrasted types. One is basic in composition and agrees in all respects with our recent basalts, the other is acid in composition and belongs to the group of lavas called porphyry, or rhyolite. In South Mountain the rocks of the latter class, which occupy about twice as much space as the basic ones, have been called slates, while their green, basic contemporaries have been known as chlorite schists. The discovery of such extensive lava fields in such wonderful preservation and so near at hand was unexpected, and deserves attention on account of its local interest.

The age of the lavas and their relations to the sandstone of the mountain, which Mr. Walcott has recently shown to be of the oldest known fossil-bearing horizon, was then explained. Attention was called to the fact that, as in most volcanic regions, large deposits of fragmental material occur (breccias, ashes, etc.), which have heretofore been considered as sedimentary beds. A large map of South Mountain, on a scale of three miles to the inch, was exhibited to show the distribution of all these rocks. Numerous specimens of the rocks themselves were also shown. Many of the porphyries are of great beauty, and are capable of extensive application in the arts, especially when polished for purposes of interior decoration."

Prof. E. D. Cope's paper was on The Fauna of the Blanco Epoch. Prof. Cope said in part: "The formation known as the Blanco has been discovered by Texan geologists and forms a part of the Great Staked Plain. I visited this region," he said, "the geology of which has been so much misunderstood, last spring, and obtained numerous fossil remains, from which I have determined fifteen species of vertebrata, all new to science and constituting a fauna intermediate between two previously known faunæ, and filling an important gap in the history of life on this continent. The species found included two tortoises, one bird, one sloth, three mastodons, one peccary, three horses, one

camel, and three carnivora. The most interesting discovery is that of a hyena, a form which has not hitherto been found in America. Its size is about that of the living spotted hyena. The other carnivora are a weasel the size of a fisher, and a cat about the size of a cheetah, both new to science. Two of the mastodons are very large, and the first (*Dibelodon humboldtii*) has hitherto been found only in South America, and the second (*D. tropicus*) in Mexico, while the third is new to science (*D. præcursor*). The horses are true species of the genus Equus—having but one toe—but one of them is remarkable for its small size, as its teeth do not exceed in size those of a sheep. The peccary is entirely a new form, while the camel ranks somewhere between the ordinary camel and the Procamelus, somewhat exceeding the ordinary camel in size."

The Biological Society of Washington.—Nov. 5, 1892—The following communications were read: The Fauna and Flora of Roan Mountain, N. C., Dr. C. Hart Merriam; Pea and Bean Weavils, Prof. C. V. Riley; The Influence of the Cross Timbers on the Fauna of Texas, Mr. Vernon Bailey. FREDERICK A. LUCAS, Secretary.

Boston Society of Natural History.—Nov. 2.—The following paper was read: Certain Aspects of the Vegetation of New Zealand, Prof. George L. Goodale.—SAMUEL HENSHAW, Secretary.

The New York Academy of Sciences has recently organized a Biological Section, which will hold monthly meetings. At the opening meeting, Oct. 17, Prof. Henry F. Osborn acted as chairman. The following papers were presented: Bashford Dean on Dionæa Under Its Native Conditions Near Wilmington, N. C.; the results of experiments emphasizing the plant's erratic sensibility and its special adaptation for capturing ground insects. N. L. Britton on a species of Hieracium; E. B. Wilson on The Artificial Production of Twins and Multiple Embryos in Amphioxus. The paper dealt mainly with the peculiarities of double monsters produced (as in Driesch's experiments on Echinus) by shaking apart the blastomeres of two- and four-celled stages, (vide Anatomischer Anzeiger, 1892.) Every gradation exists between the two perfect and separate bodies, each half the normal size, and four in which the only indication of duality consists of a bilobed condition of the archenteron. In the double gastrulas the long axes of the two halves may form any angle with each other, and the two blastopores when separate may be turned in any direction. In cases where the two blastopores face each other the two bodies are

united by a bridge of tissue at one side essentially as in the double gastrulas of certain earthworms.

SCIENTIFIC NEWS.

The Indiana Academy of Science is engaged in the publication of its proceedings since its establishment several years ago. The publication is in the hands of a committee consisting of Prof. O. P. Hay, of Butler University; Prof. C. A. Waldo, of Depauw University, and Pres. John M. Coulter, of the Indiana University. No State organization holding its meetings but once a year has better meetings with a greater variety of interesting papers than this association.

The American Microscopical Society has issued a special circular which may be obtained by all interested, of Dr. William H. Seaman, Secretary, Washington, D. C. The circular gives an outline of the proceedings of the last meeting of the Society, held at Rochester Aug. 9–12, 1892, from which we gather the following items: Twenty-nine new members were elected and twenty-seven papers were presented. The following officers were elected for the ensuing year: President, Prof. J. D. Cox, of Cincinnati; Vice-Presidents, Dr. Geo. M. Sternberg, of Brooklyn; Dr. A. C. Mercer, of Syracuse; Secretary, Dr. Wm. H. Seaman, of Washington; Treasurer, Mr. Charles C. Mellor, of Pittsburg. The circular also gives the following announcement regarding prizes offered by the Society:

The following sums of money have been placed at the disposal of the society, to be given as prizes for the encouragement of microscopical research, and Profs. Gage, Kellicott, and Seaman were appointed a committee to prepare the conditions on which they should be granted. The competition will be open to members of the society and to those who make application for membership before submitting their papers to the committee:

Two prizes of $50, two prizes of $30, two prizes of $25, two prizes of $15. The committee have prescribed the following conditions:

One prize of $50 for the best paper which shall give the results of an original investigation relating to *animal* life, made with the microscope, and not less than 3000 words in length. The methods by which the results are obtained to be given in full.

One prize of $50 for the best paper which shall give the results of an original investigation made with the microscope and relating to *plant* life, not less than 3000 words in length. The methods by which the results are obtained to be given in full.

Two prizes of $25 each for the second best papers on animal and plant life respectively, on the above conditions.

The papers, drawings and specimens entered for the above prizes to be submitted to the committee on or before July 1, 1893, and the papers and drawings to be published in the Proceedings.

One prize of $30 for the best six photomicrographs on some subject in animal or vegetable histology whose structural features are to be illustrated by the photomicrographs of the following amplification, viz., 50, 150 and 500, two of each. These are to be made by transmitted light, printed on albumen paper from untouched negatives, which with the specimens from which they are made, are to be submitted with the pictures to the committee.

One prize of $30 for the best selection of six mounted slides illustrating some one biological subject. These slides must be accompanied by a full description of the method of preparation of the specimens.

Two prizes of $15 each for the second best collection of photomicrographs and slides respectively, on the conditions above stated.

All photographs and mounted slides for which prizes are given are to become the property of the society. The object of these prizes is to stimulate and encourage original investigation in the Biology of North America, and if additional information is desired it may be obtained of the committee on prizes.

Dr. Harris H. Wilder has been appointed Professor of Biology in Smith College, Northampton, Mass.

Dr. Henry B. Ward has been appointed Instructor in Zoology in the University of Michigan.

Dr. C. S. Minot has been elected Professor of Histology and Embryology in Harvard Medical College.

November 5, 1892, was given up by the Mechanics Fair in Boston. to the Marine Biological Laboratory at Woods Holl. There were illustrations of the work of the laboratory, sets of the specimens furnished schools and colleges by the department of supplies of the laboratory, and addresses outlining the history, purposes and results of the station by trustees, pupils, etc.

The handsome new natural history hall at the University of Illinois, at Champaign, was dedicated Nov. 16. The trustees, faculty and students of the University and a large number of citizens and visitors from a distance were present. This handsome new structure has been in course of erection since October, 1891. The most approved methods of lighting and ventilation have been used in the construction of the building. It will be heated by steam as the other University buildings are. It is three stories high. The lower story is of blue limestone from Bedford, Ind., and the remaining two stories and dormer windows are of red compressed brick, and roof of slate. The windows and cornices are neatly trimmed with stone and terra cotta. The cost is about $78,000. This building will be devoted exclusively to the study of the natural sciences. It will contain the natural history library, containing more than 20,000 volumes, natural history museum, laboratories and recitation rooms. At a meeting of the trustees of the University of Illinois to-day it was decided to petition the Legislature for $350,000 to put into new buildings—a chapel, a museum and engineering building. The crowded condition of the University makes these additions necessary.